

# SCIENCE TEACHER'S WORLD

For Teachers of Science  
PLEASE ROUTE TO:

Teacher's edition of

**SCIENCE WORLD**

November 9, 1960

Edition 2

## SCIENCE EDUCATION . . . NEWS AND VIEWS

### The Conant Report

Dr. James B. Conant's *A Memorandum to School Boards: Recommendations for Education in the Junior High School Years* contains 14 "purposely conservative" recommendations.

Some of Dr. Conant's recommendations of special interest to junior high school science teachers — here quoted verbatim, but in somewhat edited form — are reprinted by courtesy of Educational Testing Service, the publisher. Copies are available from ETS, 20 Nassau St., Princeton, N. J.

### Youth Conference on Atom

Some 500 high school science students and science teachers convened at the Museum of Science and Industry in Chicago October 20-22 to discuss peaceful uses of the atom. The Youth Conference on the Atom was sponsored by industry and co-sponsored by the National Science Teachers Association and the Future Scientists of America Foundation.

Main themes of the conference were: "Science and Society," "The Atom and Electricity," "Biology and Medicine," and "Atomic Frontiers."

All lectures and discussions were on a scientific rather than a popular level. Educational advisors for the conference were: Dr. Zachariah Subarsky, Bronx (N. Y.) High School of Science; Dr. A. W. Kincaid, Superintendent of Schools, Hempstead (N. Y.), and Dr. Howard G. Spalding, A. B. Davis High School, Mount Vernon, N. Y.

► **Required Subjects for All Pupils in Grades 7 and 8:** English (including heavy emphasis on reading skills and composition), social studies (including emphasis on history and geography), mathematics (arithmetic, except as noted in the recommendation that follows), and science. In addition, all pupils should receive instruction in art, music, and physical education. All girls should receive instruction in home economics and all boys instruction in industrial arts.

The instructional program in these grades is essentially a required program; electives begin in grade 9. "The required academic subjects—English, social studies, mathematics, and science—should be given one period a day for five days a week, or the equivalent."

► **New Developments in Mathematics and Foreign Languages:** A small fraction of pupils should start algebra in grade 8. Some, if not all, pupils should start the study of a modern foreign language on a conversational basis with a bilingual teacher in grade 7.

► **Block-time and Departmentalization:** Provisions should be made to assure a smooth transition for the young adolescent from the elementary school to the secondary school.

"There should be a block of time set aside, at least in grade 7, in which one teacher has the same pupils for two or more periods, generally in English and social studies. Otherwise, grades 7, 8, and 9 should be departmentalized. . . ."

► **Challenging All Pupils:** Instruction should be organized to provide intellectual challenge for the whole range of abilities found in a junior high school. . . .

► **Homework, Marking, and Promotion:** Meaningful homework is profitable in



Dr. James B. Conant, noted educator, has completed survey of junior high schools.

grades 7, 8, and 9; drudgery, however, is not meaningful homework.

"I think a progression of homework from one hour a day in grade 7 to two hours by grade 9 is not excessive for many pupils. . . . There is a serious problem of coordination of homework assignments to prevent any one teacher from usurping too much time."

► **Program in Grade 9:** In the ninth grade, the curriculum should provide for the usual sequential elective program as well as the continuation of the required course in general education.

"I have urged that science be a full-time subject. This acceleration of the science program means that general science, as often taught in grade 9, can be covered in grades 7 and 8. Therefore the introduction of biology or a special physical science course in grade 9 has much to recommend it if the requisite laboratory facilities can be provided."

(Continued on page 9-T)

# CONCENTRATION...

One of the most forceful terms in education's lexicon, the word **concentration** is also the secret of manufacturing success. Just as we concentrate on the production of top quality laboratory glassware at the lowest cost possible, we make it possible for you to concentrate on saving a substantial part of your lab supply budget for other needed materials. If you are now using Diamond D laboratory glassware, you are getting the best value for every dollar spent. If you aren't . . . then it's time to concentrate on the problem.



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# Using Science World in Your Teaching

## Measuring and Mapping the Earth (pp. 4-8)

*Earth Science Topic:* Maps.

*Physical Science Topic:* Applications of physics to modern surveying.

*Mathematics Topic:* Geometry.

*Vocational Guidance:* Surveyor.

### About This Article

Modern map making is the subject of this article. An old decorated map dating back to colonial times shows two brigs of the British navy anchored in the Bronx River deep in New York State's Westchester County. In that area, the Bronx River is a mere trickle of a stream that could scarcely accommodate a row boat. A map of South America shows a river some 40 miles from where it is known to be. A 16,000-foot mountain looming up before surveyors fails to show up at all on one of the old maps of South America.

Happily, the accuracy of mapping has improved greatly over the past 200 years. Moreover, new methods and devices are even now being developed and employed.

This article first describes the classical, time honored, and basic principle—triangulation—on which all national maps are based. (This will be of particular interest to students in geometry classes.) The small bronze disks often found mounted in the surface of a rock or in the stone of a building and bearing the engraving: "U. S. Geological Survey" take on a new meaning. The author shows how surveyors surmount such obstacles as trees, mountains, and the curvature of the Earth. He explains why—strange to say—most of the time surveyors must work at night. The author then goes on to describe how triangulation over continents is extended to offshore islands, how triangulation is accomplished over the oceans by using astronomical bodies as "fixes." He goes on to show how methods of "vertical triangulation" can be applied to determine the height of inaccessible mountains.

Of particular interest to students in physics classes will be the instrumentation employed in modern map making (see list of instruments in question 1, below.) Finally, students in Earth Science classes will be intrigued with the light that accurate map making may throw on theories relating to the structure of the Earth itself.

### Questions for Review and Discussion

1. Describe (if you can) and indicate the use made of each of the following instruments or devices used by surveyors:

1. Invar tape
2. Theodolite
3. Bilby tower
4. Plumb line
5. Signal flare
6. Radar
7. Sofar (Sonic Fixing and Ranging)
8. Occultation camera
9. Stereoscopic camera
10. Atomic clock

2. Of what importance in map making is each of the following:

- a Laplace station
- b. Meade's Ranch in Osborne County, Kansas
- c. Bronze disks marked "U. S. Geological Survey" in rocks and buildings d. Galveston, Texas.

3. Describe the means by which triangulation over continents is extended to oceanic islands.

4. "Increased accuracy of measurements (in map making) have often had profound effects on basic scientific theories" (concerning the Earth). Present at least one such theory.

## Salmon Migration (pp. 9-13)

*Biology Topics:* Animal reproduction (fish), animal behavior (migration), hormones (role in reproduction), ecology.

### About This Article

Experienced biology teachers are aware that the topic of salmon migration has been around for a long time. By now, it has not only gotten into all the textbooks, but has found its way into the educational fare of the junior high school student and even of some elementary school pupils. What, then, is the justification for bringing up the topic again?

The justification is twofold: In the first place, new—some only recently discovered—facts are presented. In the second place, new questions are raised and actual experimentation and findings are described—all on a mature level. Moreover, the whole story is told in its broad ecological setting.

The article deals with five species of Pacific salmon. It describes their migration and spawning physiology and behavior, and then goes on to present in considerable detail experimental methods designed to discover how the fish find their way into the open ocean, how they find their way to the mouths of specific rivers, and how they find their way to specific tributaries where they breed. What the article will do, above

all, for the biology student, is to convey to him the excitement of field investigation and the lure of the unknown.

### Questions for Review and Discussion

1. What five species of Pacific salmon are identified.
2. How did the development of industrialization on the Pacific Coast affect the salmon?
3. Where do the Pacific salmon spend most of their lives?
4. Where do they spawn?
5. Describe the spawning behavior of the adult salmon.
6. What happens to adult salmon after spawning?
7. Describe the changes in sockeye, silver, and chinook salmon prior to their migration to the sea.
8. How are young salmon "tagged"?
9. Why do young salmon linger at the tidal zones on their way to the open ocean?

The following four questions have been, or are at present, the subjects for experimentation. For each of these questions, describe (1) the actual experiments that were performed (include the names of experimenters), (2) the observations that were made, (3) any conclusions reached, (4) any new questions that were raised as a result of the experimentation.

1. To what part of the ocean do Pacific salmon migrate?
2. What percentage of the fish that migrate to the sea return to spawn?
3. How do the fish find their way from the open ocean to the mouth of a specific river?
4. How do they find their way to a specific breeding tributary?

## ABC's of the Elements (pp. 14-18)

*Chemistry Topics:* The elements, the periodic table, history of chemistry.

### About This Article

When we think of the periodic table of the elements, the name Mendeleev comes to mind. Then we recall that this brilliant chemist *arranged* the elements; he did not discover them. Each discoverer conferred a name on the element he discovered. How did he arrive at the name? The author took the trouble to find out. The result, incorporated in the present article, is immensely interesting. Names are traced to places, persons, things, mythological characters, astronomical bodies, colors, tastes, and what not.

This article brings to the attention of  
(Continued on page 6-T)

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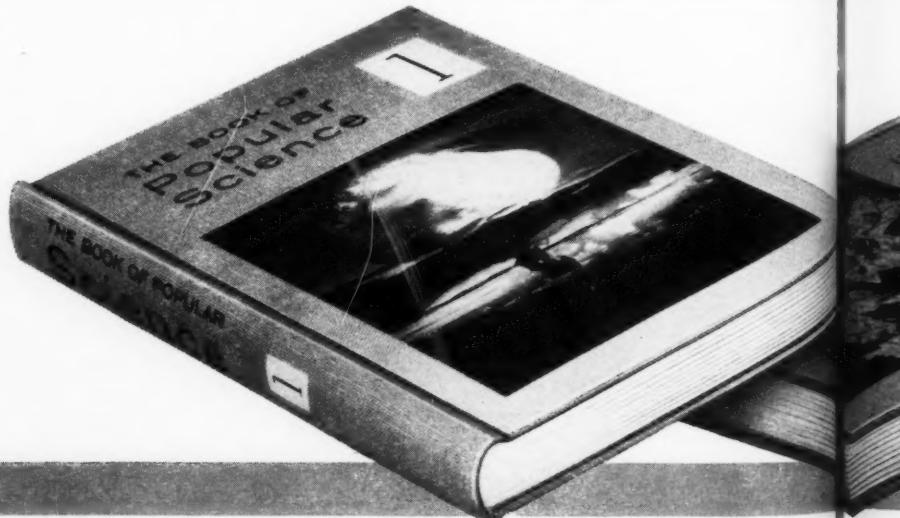
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## Using Science World

(Continued from page 3-T)

the chemistry student the names of the uncommon elements in the periodic table. At the same time, it affords a glimpse into the history of chemistry. Here are some suggestions for the reorganization of the information in this article that may make interesting student reports to the class:

1. List the countries in which the chemical elements were first discovered and the number of elements discovered in each.

2. Make a chart showing the decades from 1750 to the present and the elements discovered in each decade.

3. List the elements that are named from the Greek.

4. List the elements that have geographic names.

5. List the elements whose discoverers are unknown and state the probable origin of their names.

### Today's Scientists—

#### Dr. John Paul Stapp (p. 22)

*Biology Topic:* Space medicine.

*Physics Topics:* Acceleration, inertia, Newton's laws.

#### About This Article

To survive in space, man will have to carry his environment with him—his temperature, his air, his food. But can

he survive the unavoidable conditions for freeing himself from the Earth's gravity and for getting back to the Earth? More specifically, can he survive the sudden thrust of a rocket taking off, or the abrupt deceleration of a rocket "splashing" into the Earth's atmosphere? These are questions being investigated by the space physiologist, Col. John Paul Stapp. The present article deals, however, not only with Colonel Stapp's experiments (in many of which he was personally involved, as a subject), but also with his life from the time his missionary parents brought him to the United States at the age of six, to the present, and his position as head of the U.S. Air Force's Aero-Medical School at Brooke Army Medical Center in San Antonio, Texas.

### Tomorrow's Scientists

(pp. 23-26)

*Biology Topics:* Animal behavior (spiders and insects), life history of mosquito, life history of spider, ecology.

#### About These Reports

The reports cover two studies of animal behavior. Neither required any elaborate equipment. They can be used in the biology class to open up a veritable Pandora's box of similar projects for other biology students to undertake. Thus, David's study of the re-

sponse of spiders to light of various wave lengths can be repeated, using for the subject of an experiment such insects as ants, houseflies, fruit flies, caterpillars, roaches, and others. Ronald's work on the behavior of mosquito larvae subjected to light stimuli of various intensities can serve as a model for similar studies on fresh water crustacea, fish, mollusks, and even protozoa.

The "content" of these two reports can be brought into play by the biology teacher in connection with the study of insect life histories, animal behavior, and even evolution (adaptations).

#### For Class Discussion

1. "From time to time the (spider) cages were cleaned of all threads of silk, and the order or width of the colors were changed."

Explain why the above was necessary.

2. Formulate a hypothesis to explain the following:

When placed between red and blue or between red and green, the spiders showed a 90 per cent preference for red. When placed between yellow and blue, they showed a 70 per cent preference for yellow. There was no preference when the spiders were placed between green and yellow.

3. State at least three research problems that arise from Ronald's experiments with mosquito larvae.

elementary education in Washington, D. C. this winter.

More than fifteen hundred mathematicians are expected to attend the five days of talks and discussions at the Willard Hotel starting on January 23, 1961.

The assembled mathematicians will come from industry, government, and academic institutions. They represent the memberships of the American Mathematical Society, the Mathematical Association of America, the Society for Industrial and Applied Mathematics, and the Association of Symbolic Logic.

It will be the 67th annual meeting of the American Mathematical Society and the 44th annual meeting of the Mathematical Association of America.

### Career Booklet—Mining Engineering

The Society of Mining Engineers offers high school students a new publication, "Careers in Mineral Engineering." The booklet, which outlines the various phases of the mining industry, may be obtained from the Society of Mining Engineers, 29 West 39th Street, New York 18, N. Y.

## New Films

### Astronomy Film

The National Film Board of Canada has announced the 16mm release of *Universe*, a 28-minute, black and white sound film, which combines animation, special effects and actuality photography to present a scientifically accurate picture of the universe, based on recent advances in astronomy.

According to a statement by the Film Board, "This essay on the new astronomy explores the farthest reaches of the universe, sensed or seen by science today. It is one of our most important productions of recent years and has already won top awards at international film competitions in Cannes and Vancouver."

*Universe* is being distributed by the National Film Board of Canada, 680 Fifth Avenue, New York City. Check with your audio-visual coordinator for film libraries carrying this film.

### Physics Films

Four new films on scientific subjects may be obtained through the Bell System Operating Companies' public relations departments.

The motion pictures and filmstrips were prepared by Bell Telephone Laboratories scientists and engineers, all recognized authorities in their fields. The films contain no advertising and are appropriate for showing to advanced science students and science teachers.

The movies are: *Crystals—an Introduction* (16mm, color, sound) and *Brattain on Semiconductor Physics* (16mm, black and white, sound). The filmstrips are *Zone Melting* and *The Formation of Ferromagnetic Domains*.

Another motion picture, *Submarine Cable System Development* (16mm, color, sound), and a two-record album, *The Science of Sound*, were made available earlier under this comprehensive Aid to Education Program.

The films will be loaned without a charge to educational and professional groups.

### Math Meeting

Mathematicians of the United States and Canada will discuss hypoelliptic differential operators, first grade arithmetic, and many other mathematical topics concerning everything from basic and applied research to secondary and

# SCIENCE WORLD

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## MEASURING AND MAPPING THE EARTH

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1 COAST

3 Isthmus

7 Bay

2 Peninsula

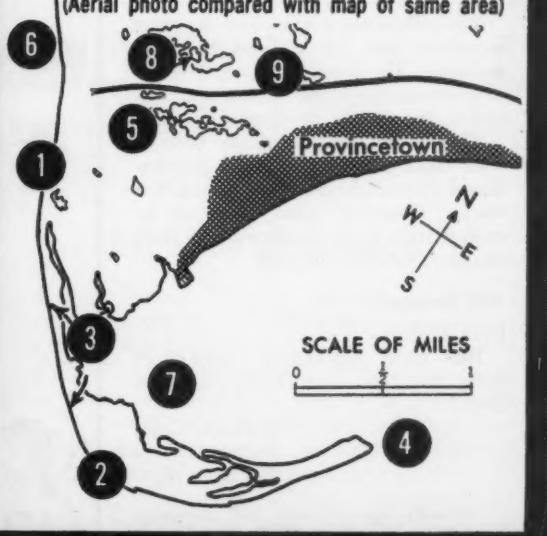
8 Island

5 Lake

9 Highway

### THE TIP OF CAPE COD

(Aerial photo compared with map of same area)





# LETTERS

## Twin Chicks

*Dear Editor:*

When a chicken egg has two yellows, does this mean that it would have hatched two chicks?

David McCain  
Ashville, Ala.

**Answer:** The yellow, or yolk, of a hen's egg is part of a single reproductive cell. The part of the cell that contains the protoplasm and—if fertilized and incubated—will grow into a chick is almost microscopic in size. The yellow material consists of proteins, fats, vitamins, and minerals. These nutrients will nourish the developing chick—a living, growing organism.

As the chick begins to develop, cell division takes place, producing a many-celled animal from a single, fertilized cell. This occurs only in the small part containing the protoplasm. Gradually, this part enlarges and membranes develop, forming a sac enclosing the yolk. An intricate system of blood vessels grows throughout the sac. If an incubated egg is opened after 40 hours, the embryo will be seen "floating" on the surface of the yolk and the blood vessels will be plainly visible.

The cells of the sac produce digestive secretions that break down the yolk materials. These materials are then absorbed into the blood system and carried to the rapidly developing chick.

That is the function of one yolk. If both yolks of a two-yolk egg are fertilized, they might possibly produce two chicks. However, there may not be enough room in the single shell for both chicks to develop normally.

## 102 Elements

*Dear Editor:*

How many elements are there as of today, and how many of them are man made?

Norman Ganz  
Rogers School  
Chicago, Ill.

**Answer:** Up to now, 102 elements have been identified. Of these, fourteen elements are man made, although traces of two of these elements (plutonium and neptunium) were later found in nature, in uranium ore.

Four of these man-made elements are stable and remain unchanged unless

acted on by some outside force. The other ten are radioactive, and always tend to break down into other more stable elements.

The interesting story of how all the elements received their names is told in this issue of *Science World* on pages 14-18.

## Pressure at 6 miles

*Dear Editor:*

In *Science World* for October 12, 1960 in the article "Life at 5,000 Fathoms," which I consider excellent, there seems to be an error. On page 9 you say that "the pressure of sea water increases at the rate of 0.445 lbs. per square inch for every foot of depth." Then, on page 10, the pressure at six miles is given as "25,000 lbs. per square inch."

Six miles is approximately 31,680 ft. If the pressure increases by 0.445 lbs. per square inch for every foot of depth, then the pressure at 6 miles should be approximately 14,112.3 lbs. per square

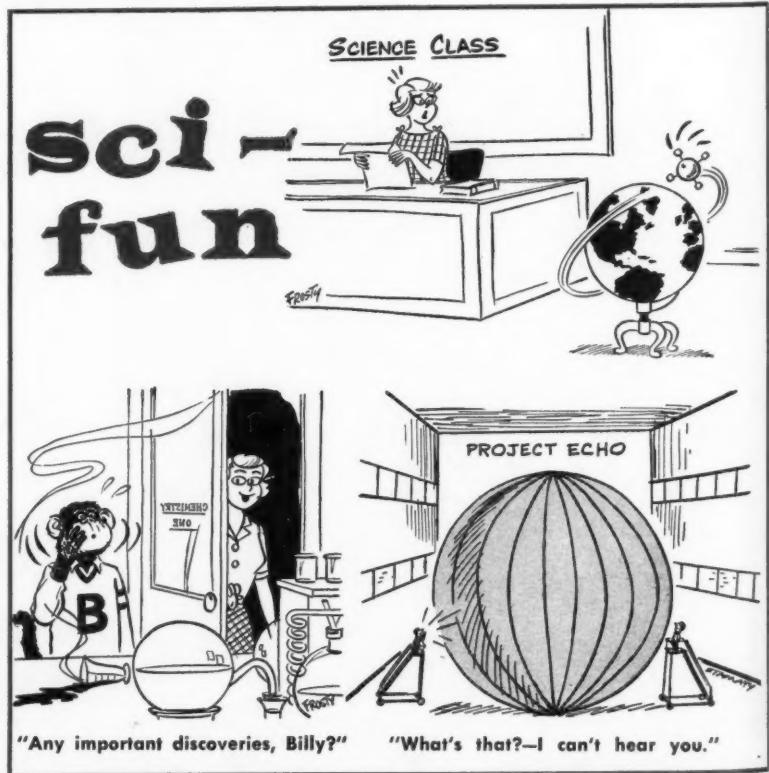
inch. This approximate figure is derived by multiplying 31,680 by 0.445, yielding a product of 14,097.6 lbs. per square inch. This is added to the air pressure at sea level (14.7 lbs. per square inch) to form the final answer.

Is our figure correct? If not, please tell me how you arrive at your figure of 25,000 lbs. per square inch of pressure at six miles.

Arthur Steiner  
Los Angeles, Calif.

**Answer:** Reader Steiner is correct. Under the extreme pressure of a dead-line, *Science World* lost a few digits before reaching bottom.

This is your department, readers. We'd like to know what's on your mind. Send your letters to: Letters to the Editor, *Science World*, 33 West 42nd Street, New York, 36, N.Y. We'll publish the most interesting ones.



# SCIENCE WORLD

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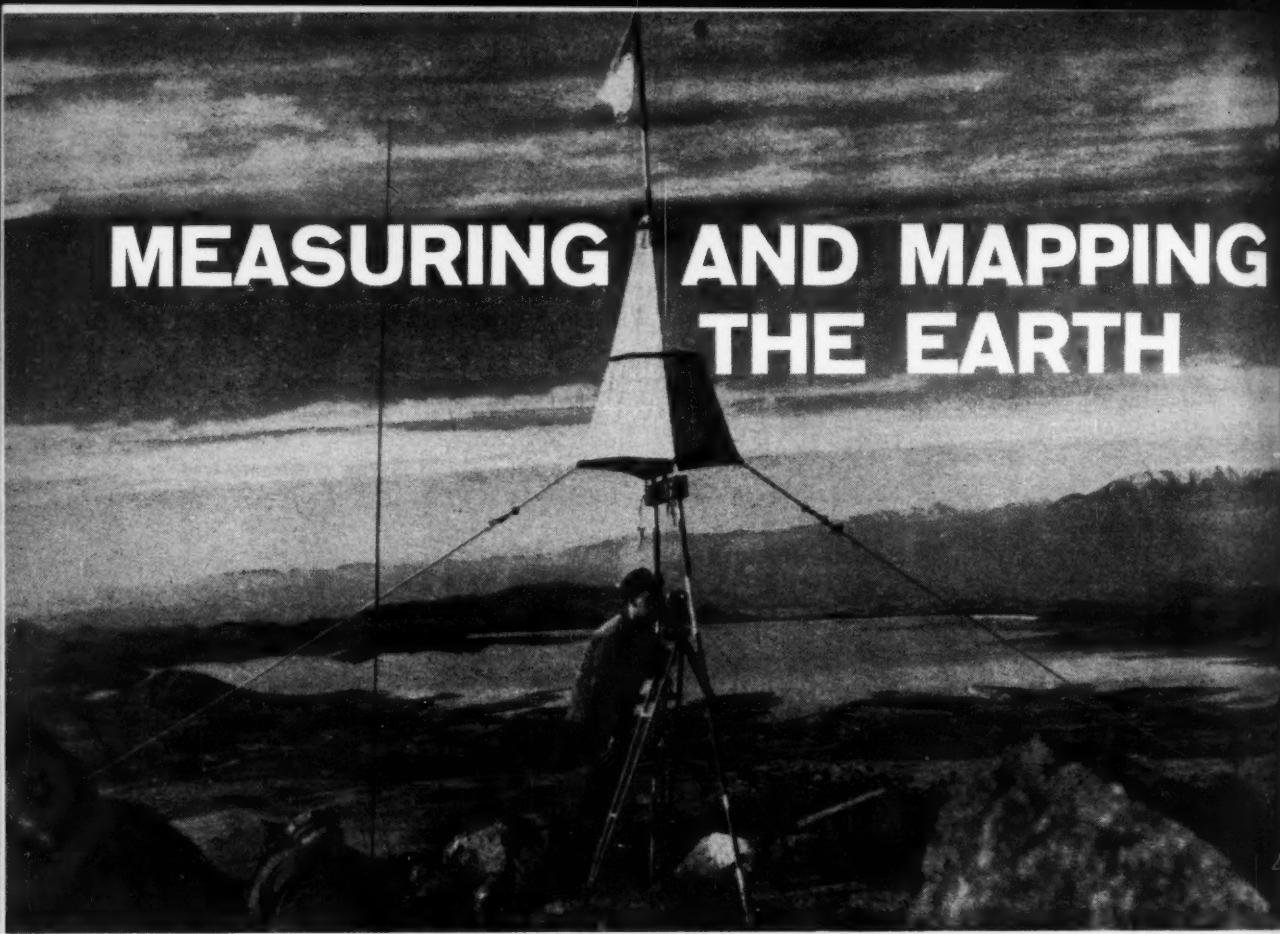
**Cover from U. S. Coast and Geodetic Survey**

### Science in Quotes

The sea lies all about us. The commerce of all lands must cross it. The very winds that move over the lands have been cradled on its broad expanse and seek ever to return to it. The continents themselves dissolve and pass to the sea, in grain after grain of eroded land. So the rains that rose from it return again in rivers. In its mysterious past it encompasses all the dim origins of life and receives in the end, after, it may be, many transmutations, the dead husks of that same life. For all at last return to the sea—to Oceanus, the ocean river, like the ever-flowing stream of time, the beginning and the end.

—RACHEL CARSON  
*The Sea Around Us*

# MEASURING AND MAPPING THE EARTH



Map making has become a science, and more accurate maps may affect basic scientific theories

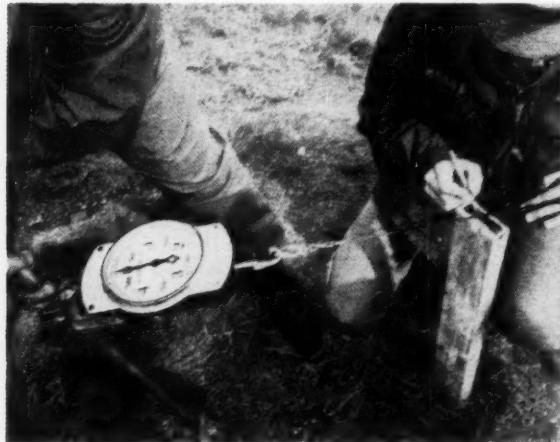
By HAROLD SLOANE

THE oldest map of which there is any record dates back to the fifteenth century B. C. It is a map of the city of Nippur in the country now called Iraq. The map, which is

on a clay tablet, shows buildings, rivers, canals, a park, and the city walls. A copy of the ancient tablet can be seen at the British Museum in London.

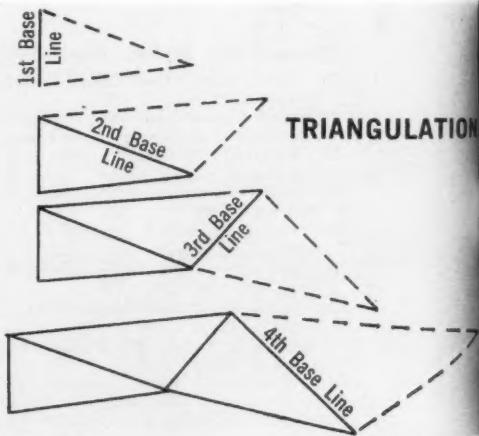
Men have been making maps for 35 centuries. Yet it is estimated that

as recently as 200 years ago, only 116 places on the surface of the Earth had been correctly located. These were places whose distance north and south of the Equator and east or west of a prime meridian had been fixed accurately. These early maps



U. S. Army Corps of Engineers photo

To establish a base line for triangulation, Army surveyors stretch nickel and steel "invar" tape with spring scale. This assures an equal stretch each time the tape is put down.



Science World graphic

The U. S. is mapped in a network of triangles. First step in triangulation is to establish a base line. Second base line is next established on first triangle, then a third and so on.

were works of art, and map making was indeed an art. The making of maps is still an art, but today it has also become a science.

Although accurate mapping has been going on for perhaps 200 years, vast areas of Africa, Asia, and South America, as well as northernmost North America and other regions have never been accurately mapped.

Recent map-making parties in South America have found that old maps show rivers as much as 40 miles from where they should be. One party climbed a 14,000-foot mountain to sight on another peak. The surveyors found an intervening 16,000-foot mountain that was not shown on any map. Even in the best-mapped areas, new highways and dams are being built, cities and suburbs are expanding, rivers are changing their course, and many other alterations taking place, making new map measurements necessary.

For small measuring jobs, in the house or yard, and on the football field, a tape measure or its equivalent is adequate. But it would cost far too much and take far too long to measure the whole country that way. And the accuracy of such a measurement would be poor.

Map makers, instead, use the method of *triangulation* on land, based upon the fact that if you know the length of one side of a triangle and two of its three angles, you can calculate the length of the other two sides.

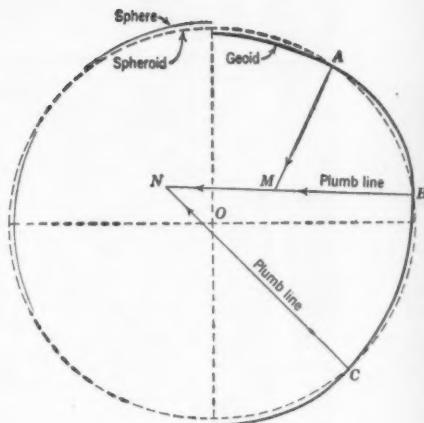
In order to start a triangulation network, surveyors do use a tape

measure. It is an *invar* (from "invariant") tape, made of nickel and steel. This alloy changes very little in length with changes in temperature, and the tape is not very elastic. A cloth tape, from the surveyor's exacting viewpoint, would be as elastic and as useless as a rubber band. Even a pure steel tape is too elastic. The *invar* tape, too, expands and contracts, but not as much as tape made of other materials.

To start a triangulation, surveyors use a 160-foot-long *invar* tape to measure a base line of five miles along a straight, level stretch. They attach one end of the tape to a post that marks the beginning of the base line. Three evenly spaced low posts support the tape. At the other end a spring balance is hooked to the tape to exert a 33-pound pull on it. This makes the tape stretch exactly the same amount each time it is put down. A sensitive thermometer lies on the tape, and from it the surveyors can tell exactly how much the tape has stretched or contracted from normal due to temperature.

### Setting Up Base Lines

The tape must be laid down 33 times per mile, and the whole base line must be measured many times at different times of the day to obtain accurate figures. For a *first order* or primary triangulation, on which national maps are based, the accuracy of the base line must be one part in 300,000. This permits an error of no more than an inch in five



Physical Geography, by Strahler (Wiley)

**Polar cross section of Earth shows it is neither a sphere nor a symmetrical spheroid. Its irregular shape (shown by solid line) is called a geoid. Thus plumb line measurements of Earth's radius are too small (AMB), or too large as at (BNC).**

miles. Actually, the U. S. Coast and Geodetic Survey, the U. S. Geological Survey, and other mapping agencies usually achieve an accuracy of one part in 2,000,000.

Having set up the base line, the surveyors are ready to make the first triangle. Points A and B mark the two ends of the base line. The surveyors select a point, C, some miles from the approximate center of the base line. With a telescopic instrument known as a theodolite (which measures horizontal and vertical angles) at point A, the surveyors sight a flag at point B. Then they turn the theodolite to point to a flag at C, and measure the angle through which they had to swing the instrument from B to C. With a theodolite at point B, the surveyors sight A and then C. Having measured the angles CBA and CAB, they calculate the distances between C and B and between C and A. Now they can use any of the three sides of the triangle as the side of a new triangle.

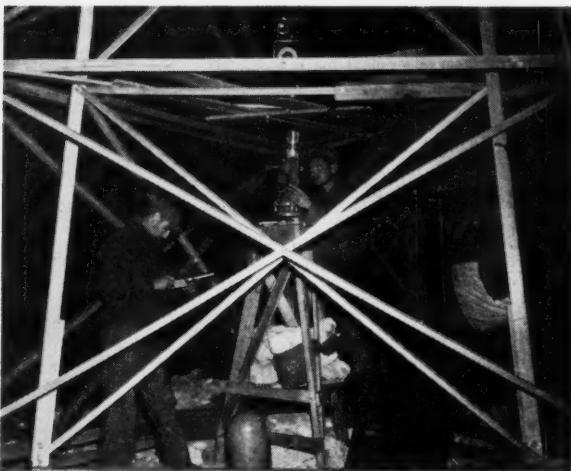
The angles of a triangle on a flat surface add up to 180 degrees. In a first order triangulation, the angles must total 180 degrees to within one second of arc. Since there are 60 minutes of arc in one degree, and 60 seconds in one minute of arc, each triangle must achieve the incredible accuracy of one part in 648,000!

Triangulation often involves much more than simply measuring angles.



U. S. Navy photo

Long before it was possible to see the curvature of the Earth shown in this photo taken with camera attached to rocket, geographers and cartographers knew that the Earth was spherical in shape. Photo confirmed evidence of indirect observations.



U. S. Army photo

**Engineers are making base line surveys at night. Daytime heat causes rising air currents which distort instrument images. At night, sharp images can be seen up to 50 miles by use of lights.**

For example, the sides of the triangles are frequently 10 miles long, or longer. In a mountainous area they may be 50 miles long.

The curvature of the Earth, however, makes it necessary to be 65 feet above the surface to sight objects 10 miles away. In forested country the surveyors can sometimes find a tall tree, lop off its top, and build an observation platform there. In mountainous country they may be able to measure from one mountaintop to another. Frequently, however, they must build a tower.

Jasper S. Bilby, a signalman in the U. S. Coast and Geodetic Survey, invented a portable steel tower. The Bilby tower, 129 feet high, is actually two towers, one inside the other. The inner one is a giant tripod on which the theodolite stands. The outer tower surrounds it but does not touch it, so that surveyors standing on the outer tower won't shake the inner one and the theodolite.

### Usually Work at Night

Most of the time surveyors must work at night, using powerful signal lights. In the daytime the sun heats the air, and currents of hot air moving upward make the image reaching the theodolite dance and wiggle. This could throw the triangulation completely off. Working from towers on mountains, on a clear night, surveyors can see beacon lights as far as 50 miles away.

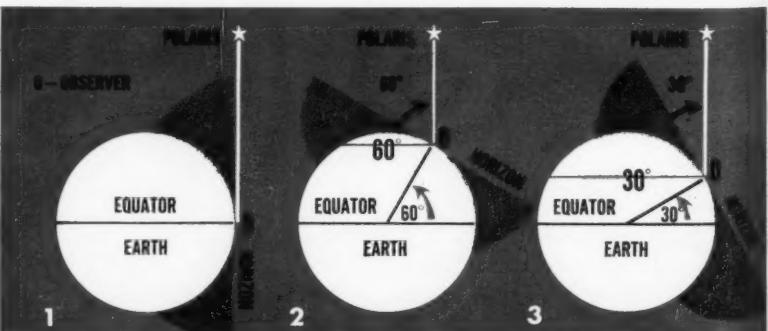
Every 40 to 100 triangles, a new control base is measured with the invar tape. If this base and the length measured in the triangulation differ by more than one foot in four miles, the triangulation must be repeated from the last check base.

In a large triangulation, the shape of the Earth can create grave errors after 20 or 30 triangles. The Earth, after all, has a curved surface, and even worse, it is slightly flattened at the poles. Furthermore, the density of the materials within the Earth's crust varies from place to place, and the density of these masses determines the force of gravity. For example, a layer of heavy basalt underground would be responsible for more gravitational force than a layer of light porous rock or clay. Surveyors determine the vertical with a plumb line, and the weight at the end of

the string points in the direction of the force of gravity. Thus, while the plumb line appears to hang perpendicular to the surface of the Earth, it does not necessarily point to the center of the Earth.

These irregularities in the Earth's crust can give the apparently level surveying instruments a tilt that is not easily detected. To correct for this error, every 20 to 30 triangles the surveyors must take measurements from the stars to find the zenith and determine the true vertical direction. Then they adjust their triangles according to the astronomical information. Places where they observe the stars and "true up" their triangles are known as *Laplace stations*.

Star measurements to determine latitude and longitude are also taken to help check on the triangulation.



**In Northern Hemisphere, observer can determine latitude by measuring altitude of Pole Star. At Equator, Pole Star is at 0° angle. At North Pole, it would be at 90° angle.**

Science World graphic

The process takes some time, for the measurements must be carefully taken if they are to be more accurate than the triangulation itself. (When navigators take latitude and longitude on a ship they do it quickly, but they usually consider the measurement accurate if it places the ship within a couple of miles of its true location.)

The triangulation of the United States was not carried out all at once. Indeed, it is still going on. Many lines of triangles starting at different places, usually on a coastline, have been made over many years.

To draw them together into one network, the U. S. Coast and Geodetic Survey selected a spot near the geographical center of the country and there centered all the triangulations. The place is Meade's Ranch in Osborne County, Kansas. On a concrete monument sunk in a pasture there, a bronze disk with a little cross mark in its center marks the base spot of all U. S. mapping.

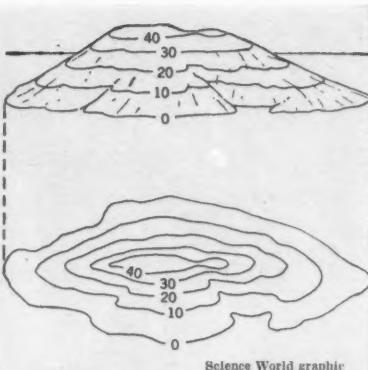
Canada and Mexico, too, have adopted Meade's Ranch as the center of their mapping systems, so the whole continent of North America is mapped from there. The little disk is called "the North American datum of 1927," for it was in that year that all the triangulations were corrected to make Meade's Ranch their point of origin.

### Mapping by Radar

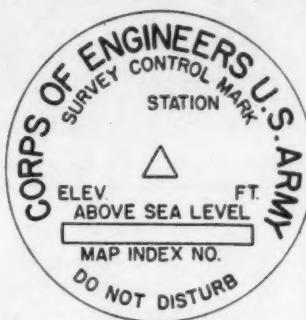
Today the United States is covered by a network of about 12 east-west arcs of triangulation, and about 30 north-south arcs, totaling about 65,000 square miles. Thousands of bronze disks, called bench marks, are fastened to rocks, buildings, or little concrete monuments to mark the triangulation stations of this vast network. The bench marks furnish a base for second-, third-, and lower-order triangulations.

Surveyors who want to locate accurately and measure any piece of property start from one of these markers, or from a second- or third-order marker originally measured from the first-order stations. In fact, everything that appears on a map is measured from the triangulation network, although the network itself does not appear on the map.

**It is impossible to triangulate clear**



Sketch shows how elevations of hill are translated into contour lines on map. Lines show height and shape.



Disk above is used to mark triangulation stations. These "bench marks" are in permanent locations.

across an ocean, but in recent years aircraft have helped extend triangulations to islands off shore. An airplane flying halfway between Florida and an island in the Caribbean, for example, drops a parachute flare at 30,000 feet. Several sighters in Florida and several on the island follow the slowly falling flare. At a radio signal, they take a simultaneous "fix" on the flare. The exact location of the island can be derived from these fixes, and the triangulation network can be extended from island to island. In this way, Puerto Rico was brought into the triangulation net of the North American continent.

More recently, surveyors have been testing radar as a means of establishing base lines and replacing invar-tape measurements. The microwaves of radar are electromagnetic waves which travel at the same speed as light waves. The speed of light is known (186,282 miles per second is the average of measurements made over the past decade), and radar in-

struments are so sensitive that they can measure the travel time of a radar signal with an accuracy of better than one part in a million.

From this measurement we can derive the distance over which the radar signal traveled. And by dividing this distance (from radar to target and back to radar) by two, we can derive the distance between the points at each end of the base line.

Dr. J. L. Worzell of the Lamont Geological Observatory of Columbia University, in New York, believes that one day it may be possible to triangulate across the ocean, using SOFAR (Sonic Fixing and Ranging). In this technique an explosive charge is set off about 4,200 feet deep in the sea. At this depth the temperature, density, and salt content of the water hardly change from place to place, and sound waves travel at a uniform speed. Distance could be calculated by measuring the travel time of the SOFAR signal.

In order to establish triangulation stations in the sea, the scientists would have to place on the ocean floor permanent markers capable of giving a signal, or at least an echo, when struck by a SOFAR sound wave. Thus, the markers could be located accurately by a ship on the surface. Such devices are theoretically possible and will probably be built within a few years.

### Measuring Continents

An interesting technique using the moon may soon furnish precise measurements of distances between continents. Several stations in various parts of the world simultaneously record the time when the moon eclipses a certain pre-selected star. If the timing is accurate to some millionth parts of a second, the difference in time that the eclipse is seen in one place on Earth and in another furnishes an accurate measurement of the distance between the two spots.

An "atomic clock" at the National Bureau of Standards in Washington, D. C., which counts the frequency of vibrations of an excited atom of cesium, is used for the timing. This "clock" is accurate to hundred millionths of a second. However, one observation station on the Earth may see the star eclipsed by a mountain on the edge of the moon, and an-

other station may see it eclipsed by a nearby valley on the moon. Thus the timing is made inaccurate. Therefore, a special camera has been developed to photograph *occultations* (eclipses) of stars by the moon, so that the irregularities on the moon's edge can be studied.

Of course, we already know the distance from New York to London, for example, to within perhaps a half mile. At the moment there is no practical reason for knowing it any better. However, when mail is transported in rockets, it will be essential to know the distance to within inches. Otherwise fast-moving rockets might come down on a building instead of on a landing pad.

If we had known 100 years ago exactly how far apart the continents are, we might have been able to find out by now whether the continents are moving apart, moving together, or staying in place. This would have furnished us with valuable clues as to whether the Earth is shrinking or expanding (*see Oct. 12 issue*).

Increased accuracy of measurements have often had profound effects on basic scientific theories. As Dr. Worzell says, we probably do not have enough vision to realize the practical benefits that might result from knowing the exact size of the Earth and the exact distances between various widely separated points.

### Mapping from the Air

In addition to locating points on the surface of the Earth, map makers must know the height and depth of mountains and valleys, in order to indicate topography on a map. Actually, the Earth would have a glassy, smooth surface if it were reduced to the size of an orange. The orange, with its deep pores, has a far rougher topography for its size than the Earth. But to men on the surface of the Earth, hills and mountains loom large and are quite important.

To measure the height and depth of surface features, map makers employ a standard height as a starting level. This is the surface of the sea. But sea level is as much as two feet higher off the northern coasts of the U. S. than off the southern coasts. The Pacific Ocean on the West Coast seems to be two feet higher than the



Aero Service photo

**Most realistic of all relief maps are three-dimensional plastic maps. Here cartographer is modeling master die for such a map in aluminum. Area is foothills of Sierras.**

Atlantic Ocean on the East Coast. As a standard reference sea level, U. S. mapping agencies have chosen the average level of the Gulf of Mexico at Galveston, Texas.

Vertical triangulation can be used to determine the height of a mountain, especially if it is inaccessible. But surveyors usually employ the much more accurate method of "spirit leveling."

This method uses a telescope that contains a spirit level attached to a complex optical system. The telescope is carefully leveled while aimed at a rod held upright by a man some distance away. The rod is accurately marked in feet, tenths of feet, and even smaller units. The surveyor can read from the rod how much higher or lower it is than the telescope and than other rods held nearby, and thus determine the changes in topography. Usually the mapping teams try to go across the most level country available. Later they measure heights of hills and mountains from the base established by the first spirit-level network.

But this technique has been largely abandoned today in nationwide measurements. Instead, stereoscopic air photographs are employed. These are used in pairs, and can give a striking three-dimensional view of the land, from which highly accu-

rate topographic maps may be drawn.

Complex cameras, projectors, and other instruments, as well as skilled technicians, are necessary for this work. But the principle is the same as that used in "3-D" moving-picture cameras and projectors and in stereo still cameras and viewers.

### Contours in Stereo

Two views of one area, taken from different locations, supply the raw material. One view is projected in red and the other in blue, and the mapper wears glasses with one lens colored blue and the other red. Thus, each eye sees only one of the two pictures. The brain combines them into a stereoscopic image, just as it does the two different views that our eyes normally see. From this the mapper can draw in contours with great accuracy, producing a topographic representation of the surface of the Earth, showing hills, valleys, and other up-and-down features in detail.

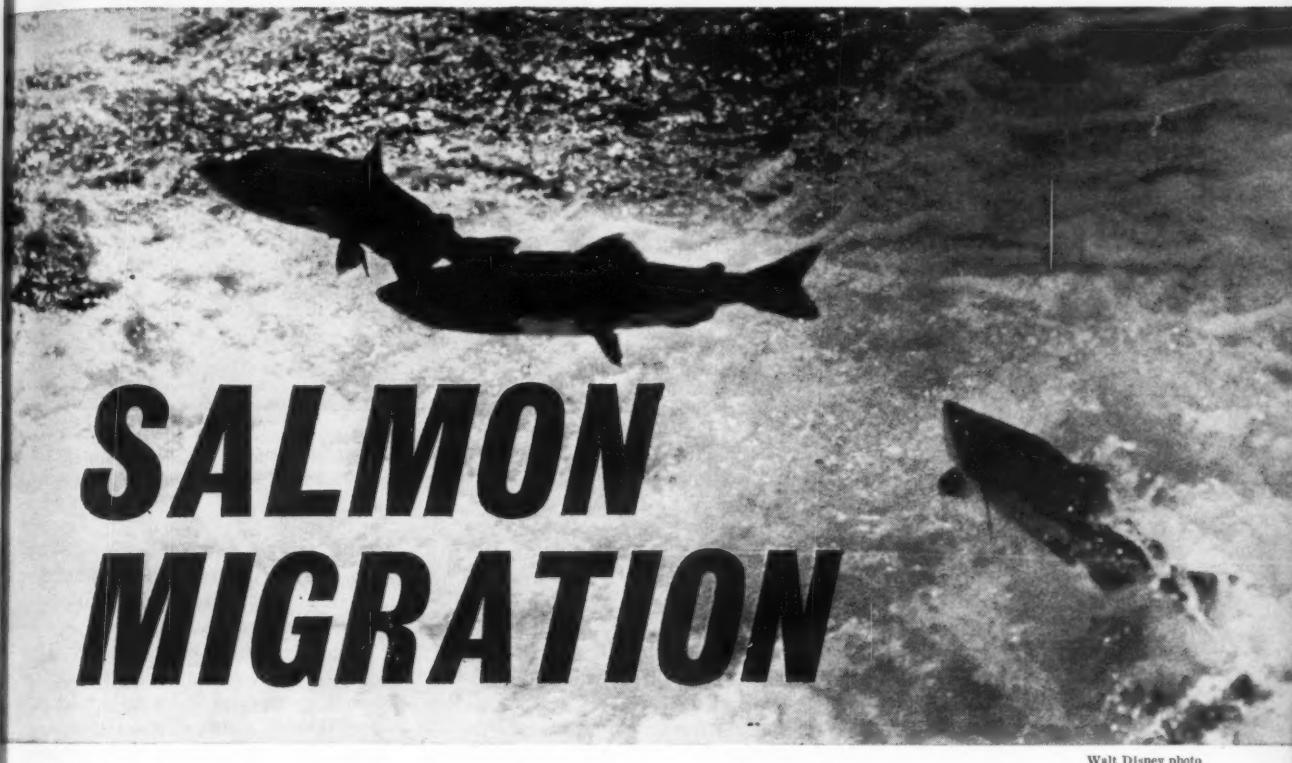
Thus, in many places aerial photography permits the surveyor to record in a flash pictures of the landscape which would have taken weeks to survey on the ground. But the man on the ground is still needed to establish the base points, and thereby piece together the pictures.

By JACK SUSSMAN

**Scientists seek the cues that enable the salmon to find its way home over thousands of miles**

# SALMON MIGRATION

Walt Disney photo



THE northern coast of the Pacific Ocean is the realm of the "King of fish," the Pacific salmon.

The Indians of our Pacific Northwest have been fishing the great annual "runs" of salmon for centuries. Among the Indians, legends and prayers grew up around these fish. They seemed to rise from their birthplace in the gravel beds of swift streams, linger there awhile, then migrate downstream to disappear into the sea. And each year adult salmon returned to the rivers where they were born, to spawn, reproduce their kind, and die—continuing the cycle of migration and return.

To answer fundamental questions about animal behavior, and to preserve these beautiful and valuable fish as a resource for the future, scientists are working on the riddle of the salmon's migratory behavior.

The problems biologists are attempting to solve are these: What are the conditions that "trigger" the salmon's seaward journey? How do

the fish adapt to the sharp change in environment as they move from fresh water to salt water? Where do the salmon go after leaving the coasts? And—above all—how does the salmon remember its parent stream after a journey that takes it hundreds or even thousands of miles to sea?

The salmon spend two to seven years in the sea, depending upon their species—pink or humpback, silver, sockeye, chum, and chinook or king salmon. They return to fresh water only once—to spawn and die.

### The Homing Urge

The remarkable accuracy of the homing urge cannot be doubted. It has been demonstrated many times. Perhaps the most convincing demonstration was carried out on British Columbia's Fraser River by three Canadian biologists.

The three scientists—Dr. Andrew L. Pritchard, Dr. Wilbert Clemens, and Dr. Russell Foerster of the Uni-

versity of British Columbia—marked and released 469,326 young salmon taken from one of the Fraser's tributary streams. Two years later, after the salmon had completed their seaward migration and returned, the scientists recovered nearly 11,000 in the same stream from which they had started. Even more exciting was the fact that not one of the marked salmon wandered into another stream.

When the salmon start their homeward migration, they are sleek, silvery, and symmetrical. After hurling themselves time and time again over falls and rapids, and wriggling through shallows, the salmon—who ceased feeding when they left salt water—soon lose their bright beauty. When they reach the tributary or pool which signals journey's end, the fish are thin, almost ragged. They have enough strength to lay eggs and fertilize them. The act of spawning completes the cycle of life.

When salmon reach the home-



Jack Sussman

**Fisheries biologists have worked out methods of rearing salmon in hatcheries.** Photo shows hatcherymen selecting females whose eggs will be used to rear young salmon in hatchery.

stream, the spawning female makes a nest in the gravel of the stream bed by digging with her fins and body. There she deposits several thousand eggs. The eggs are fertilized when the males release the sperm-containing milt over them.

The gravel nests protect the developing embryos from predators—trout primarily. Yet the porous gravel permits oxygenated water to circulate around the eggs. As the embryos grow, they are nourished by the yolk, which makes up the bulk of the egg. About 120 days after the eggs are deposited and fertilized, the yolk is absorbed by the fish. The young fish, now called a "fry," emerges from the gravel nest and becomes a free swimmer.

The fry of pink and chum salmon cannot survive long in fresh water. They swim to sea soon after emergence. The fry of sockeye, silver, and chinook salmon, however, cannot survive in salt water. They remain in fresh water streams as long as three years.

In these three species, the beginning of migratory behavior is signaled by biological changes—both external and internal. Black marks, called "parr marks," disappear from the sides of the young fish and a silvery pigment is deposited in the scales. Biologists believe that at this time the thyroid and pituitary glands become active. They produce secre-

tions that enable the fish to adapt to salt water.

Fisheries biologists have trapped fish in this stage of development and placed them in observation pools. The scientists observed that the young fish were very active at night. They formed schools and aligned themselves with the current to point downstream. If fish penned in observation pools are not permitted to migrate, these behavior patterns fade, and the urge to migrate disappears.

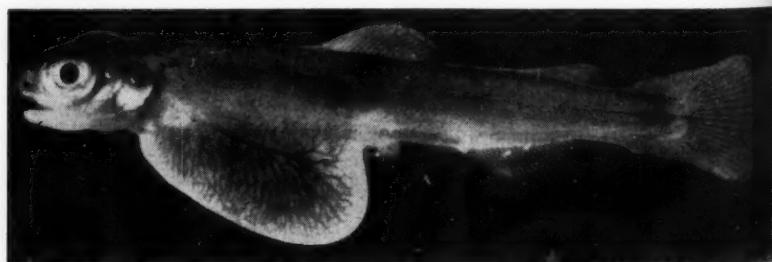
#### Navigation in Ocean

It is at this stage of development that the sockeye, silver, and chinook salmon begin their downstream migration. As the migrants approach the mouth of the river they slow down. They linger a short time in the tidal estuaries where fresh and salt water meet and mix.

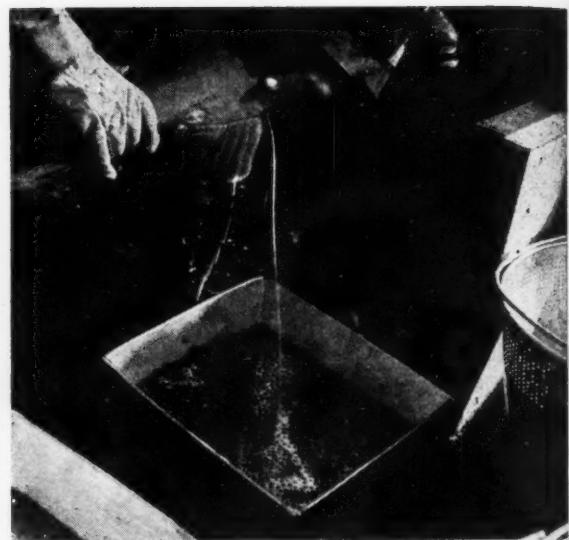
The salmon's adaptation to marine life is completed in the tidal zone. It then moves on to its feeding grounds in the ocean.

Where do the salmon journey after leaving the salt estuaries? To trace the migration of salmon, biologists mark them. This is done in several ways: by clipping off the *adipose* (fatty) fin near the tail, by attaching metal tags to one of the fins, or by removing one of the *ventral* (belly) fins.

The migrations have been traced by scientists aboard research vessels and by fishermen who report catches of marked salmon. It is known that chinook salmon from the Columbia River in Washington and sockeye salmon from the Fraser River in British Columbia, migrate beyond Alaska's Aleutian Island chain into Siberian waters—a distance of 2,500 miles.



**Fifty-five days after fertilization, the salmon has developed into "yolk sac stage" shown above. At this stage, the fish still lives in the gravel nest and is nourished by the yolk material remaining in the sac on its ventral (stomach) side.**



Washington State Department of Fisheries

During the ocean life phase, the salmon eat heavily and grow to adulthood. The return migration apparently begins when the salmon are mature and ready to lay eggs.

How the salmon navigates in the open ocean and finally locates its home stream is still an unanswered question. Dozens of experimental releases of marked fish for half a century prove that some marked adults always return.

Dr. Arthur D. Hasler of the University of Wisconsin is conducting experiments on the problem of fish navigation. He separates the problem into two major parts: (1) How do the salmon recognize the main river and their home tributary? (2) How do they find their way from the open ocean to the home river without visual landmarks?

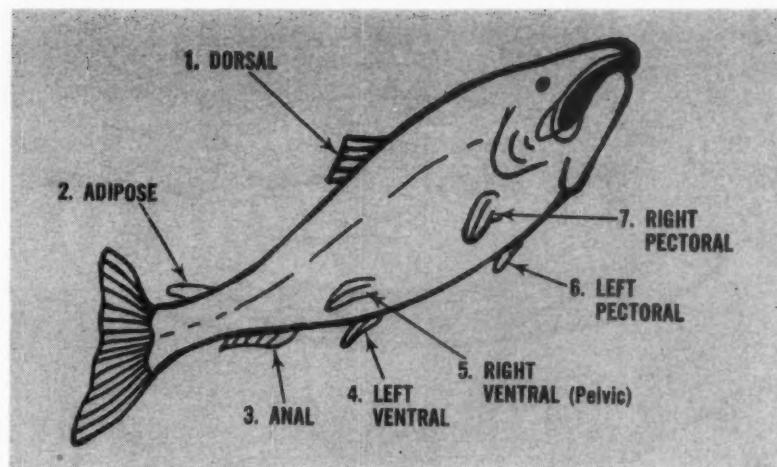
In an attempt to solve the first part of the problem, Dr. Hasler and his associates have hypothesized that young salmon are "imprinted" with the odor of the home stream during their early fresh water phase. In other words, the salmon learn the particular odor of the home tributary and remember it.

Dr. Hasler and his associates have shown experimentally that salmon and other fish have remarkably sensitive organs of smell. Fish can detect unbelievably small amounts of certain chemicals (for example, beta-phenylethylalcohol) dissolved in water. One experimenter estimates that an eel can detect this chemical if as little as two or three molecules reach its organs of smell.

One question Dr. Hasler and his associates asked was this: Do streams have distinct and characteristic odors

**Scientist is clipping the fins from a young salmon. Fish can now be identified in studies of salmon migration routes.**

Washington State Department of Fisheries



Science World graphic  
Scientists remove one or more of the seven fins of the salmon to identify them in studies of migration routes and homing accuracy. The fins may be cut on young fish beginning migration, or on adults caught at sea before they begin homing migration.

that remain nearly constant from year to year? They analyzed water in different streams and found that the answer was yes.

The next question was this: How could these odors be used by migrating fish?

#### Odor—Possible Cue

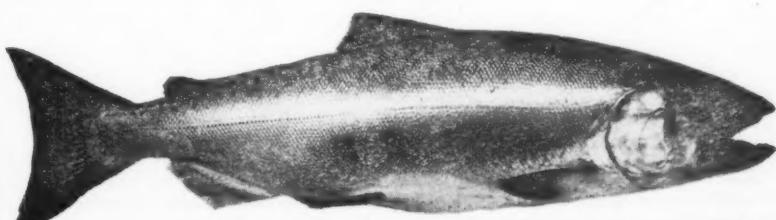
Setting up a laboratory demonstration with blunt-nose minnows, Dr. Hasler conditioned these fish to respond positively to one odor and swim toward it, and to reject another odor and swim away from it. This learned behavior did not disappear even after a long period, provided the fish had been trained when very young. The method which proved successful with the blunt-nose minnow was then tried on young salmon brought to Wisconsin by Dr. Hasler. After an initial training period, the salmon learned to recognize the difference in odors between two Wisconsin streams.

In 1954 Dr. Hasler performed a field experiment on mature silver salmon returning to spawn in Issaquah Creek in the Puget Sound area

of Washington. He trapped 302 specimens after they had passed a particular fork in the stream. Then he plugged the nostrils of half these fish with cotton and returned all of them to the water *below the fork* where they had been trapped.

The unplugged (or control) fish made the same choice they had made the first time, and continued up the river. The plugged fish made random choices, about half of them going up each fork. This tends to confirm Dr. Hasler's hypothesis that smell is one factor in upstream home-seeking migration. These experiments all point to the fact that odors learned and memorized may play a part in salmon migration.

Knowledge of the phenomenon of odor imprinting may prove of great practical value in salmon conservation. Dr. Hasler suggests that young salmon taken from their home streams at an early age could be "imprinted" with odor memories that would lead them to safe streams and hatcheries. Thus, thousands of salmon, now lost passing dams on downstream and homing migrations,



Washington State Department of Fisheries  
"Bright" is fisherman's word for chinook above—38 inches long, 45 pounds in weight.

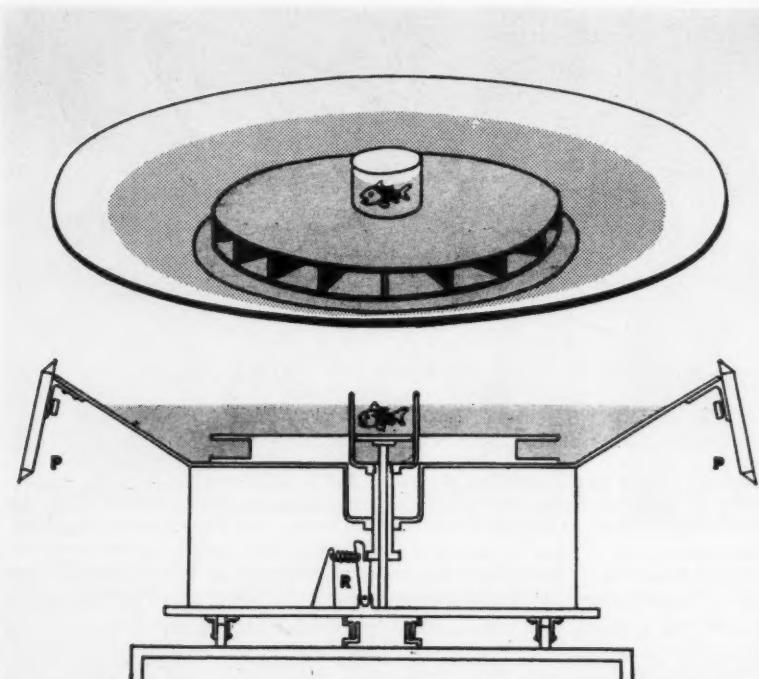
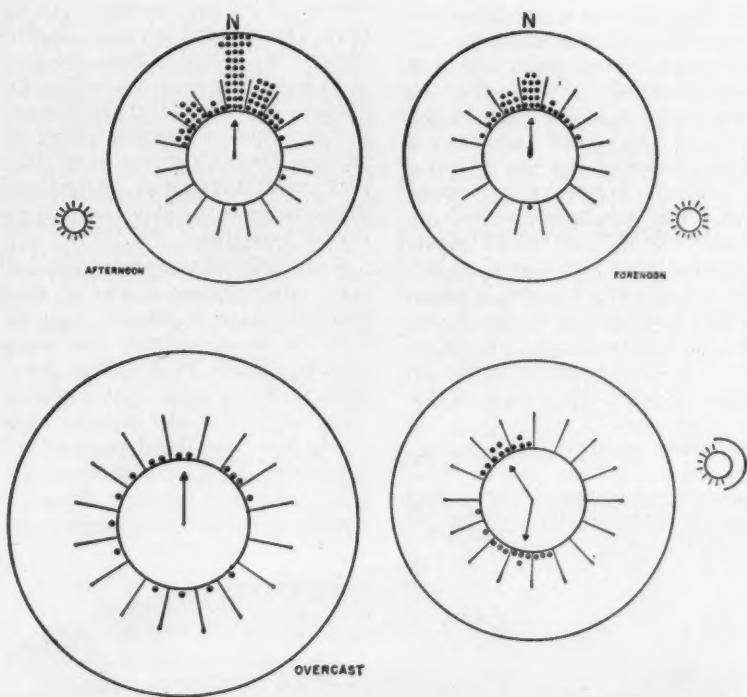


Diagram shows tank used by Dr. Hasler in training fish to swim in a particular compass direction. Top view shows hidden compartments—all but one of which are closed in training. Side view shows observation periscopes (P), release (R).



Dr. Arthur D. Hasler

Fish trained to seek north could locate north as long as sun was shining, or with lamp at same angle as sun. Circles in compartments show scores (solid circles, forenoon; open circles, afternoon). Cloudy days, fish moved at random.

could be led to safe tributaries. Thousands of others that home unerringly to polluted streams, could be led to fresh, clear spawning places. There a large fraction of the eggs would survive to hatch.

Odor recognition may be the answer to the problem of home finding in a river and stream system, but how does the salmon find the mouth of the river? It seems to Dr. Hasler that the odor memory hypothesis does not explain the movements of salmon in the open ocean.

Using fish whose homing behavior is much less complicated than that of the salmon, Dr. Hasler has demonstrated that fish may navigate by orienting themselves with the sun as a reference point.

### Sun "Compass" Experiments

The first experiments of this nature were conducted in Lake Mendota, Wisconsin. The scientists netted white bass on their breeding grounds and marked them with a bobber attached behind the *dorsal* (back) fins. They transported them to another part of the lake, where they were released.

Results: On sunny days the take-off direction was north, toward the breeding grounds. On cloudy days the fish swam randomly in all directions, apparently unable to orient themselves.

These experiments suggest that fish may utilize some kind of sun "compass" and biological "clock," similar to those thought to guide the migration of birds and insects.

The next step was laboratory tests under the open sky. The apparatus used was a tank containing a circular trap with 16 compartments (*see diagrams*). Each of the 16 compartments could be opened or closed as the experimenter wished. Experiments were conducted with a number of fish. Each fish was placed in a cage on top of the compartmented trap. Then the fish was released and given a small electric shock sufficient to frighten it.

You may have noticed that frightened fish usually dive for the nearest cover. The only available hiding place was the one compartment left uncovered by Dr. Hasler. This operation was repeated several times with the open compartment always in the same compass direction—north. The

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fish was trained to go from the cage to that one compartment.

Then Dr. Hasler repeated the tests with all compartments open. The tests were conducted between 8:00 a.m. and 9:00 a.m., and again between 3:00 p.m. and 4:00 p.m. It was found that on sunny days the trained fish almost always chose a hiding place which lay in the compass direction to which they had been trained. On cloudy days, however, the fish were disoriented and showed no pattern. "This," Dr. Hasler says, "demonstrates that the sun was the fish's point of reference and that the fish had learned to seek shelter in the same direction at different times of day—that is, to allow for the movement of the sun."

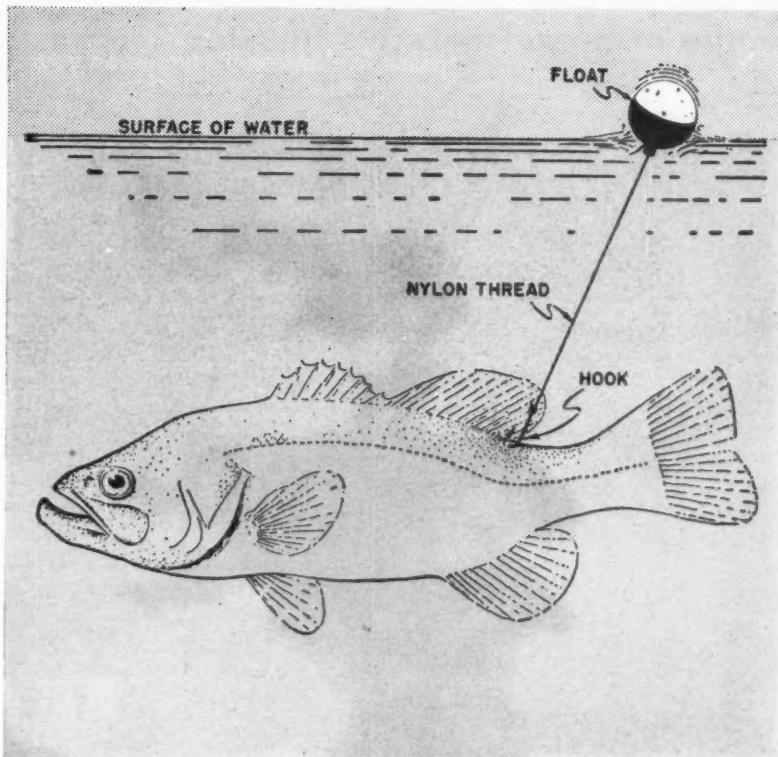
Similar experiments were conducted in a perfectly dark room with an electric light as an artificial sun. The results were substantially the same, with the fish responding as though they were responding to the real sun out of doors at that time of day. From these experiments, Dr. Hasler hypothesizes that fish have an orientation rhythm associated with the so-called biological "clock," which is believed to guide many other species in their migrations.

### Needed—More Experiments

Dr. Hasler admits that orientation by the sun is only part of the answer to open sea navigation by salmon. There is still this question: How do the fish know which direction to choose?

Dr. Hasler feels that close to shore a number of stimuli and responses may serve as cues. The sun hypothesis does not rule out visual cues, such as rocks and the shape of the underwater coastline. "It would be very interesting," he says, "to know what the fish do at night."

At the University of Washington School of Fisheries in Seattle an interesting attempt was begun in 1952 by Dr. Lauren Donaldson to start a run of silver salmon where none had existed before. Young silver salmon were hatched and reared at Soos Creek Hatchery in the Puget Sound area. Thirty-six thousand of these yearlings were then marked by removal of the *right ventral* (belly) fin and transferred to another hatchery at Issaquah, Washington. An



Dr. Arthur D. Hasler

**Another method of demonstrating ability of fish to orient themselves was used by Dr. Hasler in Wisconsin lake experiments. Fish taken from breeding grounds were tagged with float. When released, the float plainly marked direction of take-off.**

equal number were marked by removal of the *left ventral* fin and sent to the university hatchery located on a canal running through the heart of Seattle. After one month in holding ponds in each location, all the fish were released at one time. All migrated to the ocean.

In the return migration, two years later, none of the marked fish appeared at Soos Creek Hatchery where all had been hatched and reared for their first year. Seventy fish tagged at Issaquah Hatchery returned there. And the University of Washington received 124 fish released from its pond. Only one fish strayed—a male released from the university ponds went to Issaquah Hatchery. A successful salmon cycle had been established at the university, where no run had existed before.

The University of Washington's pond does not resemble a normal spawning ground. It is not located on a stream, but alongside a polluted, slow-moving ship canal. The water coming down its fish ladder during

the spawning season is very small in volume, much less than that at either Soos Creek or at Issaquah Creek. Its water temperature is also unfavorably high. Yet, in spite of these unfavorable conditions, the fish returned to the point of release rather than the point of hatching.

A more refined experiment might tell us something about the unreported fish. Were some of them "looking for" Soos Creek but unable to find it? For the University of Washington scientists, the significant point of this experiment was that the salmon returned to the point of release.

The mystery of the migrating salmon is far from solved. The work of the biologists investigating this problem seems to indicate that some form of sun "compass" may guide salmon in their navigation. The evidence to support such a theory is inconclusive, but as more information accumulates, more precise experiments can be planned. Dr. Hasler says, "We have here opportunities of unlimited potentiality, exciting to contemplate."

In the names of nature's building blocks are found hidden great

# ABC's of

By ISAAC ASIMOV

**A**S YOU read this, scientists are at work trying to discover element 103. They know where it will fit into the periodic table, and they can predict what its characteristics will be. But what will they call it? Before they name element 103, they will have to agree on a name for element 102.

The discovery of element 102 by nuclear bombardment in the cyclotron was reported at the Nobel Institute for Physics in Stockholm, Sweden, in July, 1957. Its discoverers named the element *nobelium* to honor Alfred Nobel, the Swedish chemist who invented dynamite and endowed the Nobel prizes. But the name is not yet official. If it is accepted internationally, it will mark the fifth time that a scientist has been so distinguished in recent years.

Earlier, between 1952 and 1955, elements 99, 100, and 101 had been produced at the University of California in Berkeley, California, also by nuclear bombardment. They were christened *einsteinium*, *fermium*, and *mendelevium*, respectively, after Albert Einstein and Enrico Fermi (for their contributions to our understanding of the atom) and Dmitri I. Mendeleev (for his part in the development of the periodic table).

The same California group had produced element 96 in 1944 and named it *curium*, after Pierre and Marie Curie. (It was from curium, by the way, that element 102 was synthesized.)

Not all elements have been so happily named. In fact, a good many commemorate mere trivialities. Consider, for example, the only two elements besides those already mentioned that have been named for people. In 1794 the Finnish chemist Johan Gadolin found a new kind of mineral near Ytterby, a little place

three miles from Stockholm, Sweden. Between 1803 and 1907, fifteen new elements were isolated from this mineral or others like it. One of these, element 64, was consequently named *gadolinium* by Lecoq de Boisbaudran, a French chemist who was one of its discoverers. A good enough choice, that. Earlier, however, the same chemist had detected element 62 in a mineral called "samarskite" and identified his find as *samarium*. This mineral had been named after a Russian mining engineer, Samarski. In this way, a completely unknown Russian was honored by the naming of one of the basic building blocks of the universe.

The story behind the names of the

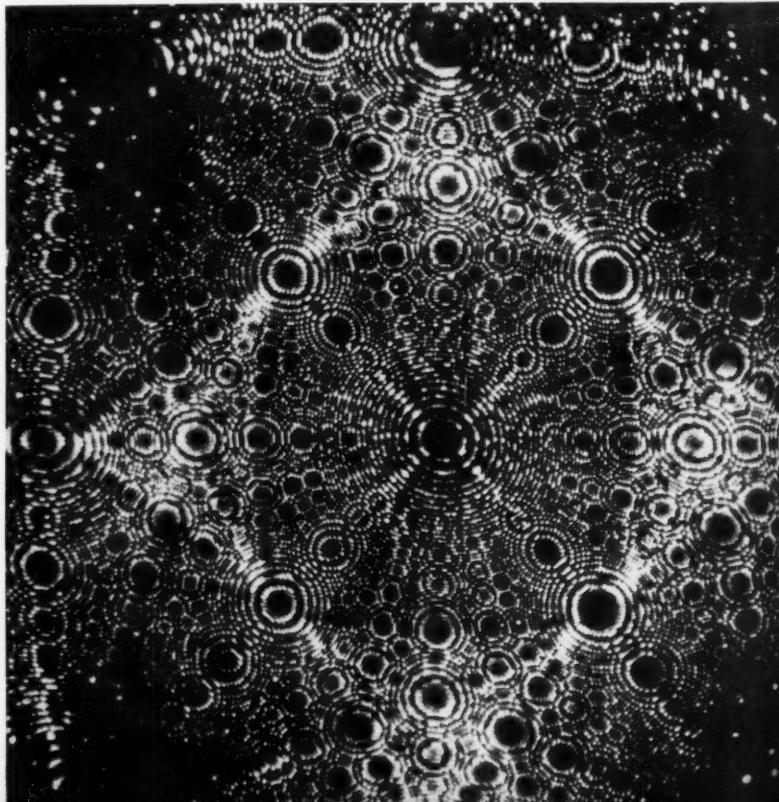
elements is a fascinating one, whatever the source. Hidden in them are patriotism, poetic feeling, human irritation, scientific mistakes, and monuments to milestones in chemical history. Let us take a roll call.

## Place-named Elements

To begin, more elements are named after places than persons. For instance, the French chemist Georges Urbain discovered element 71 in 1907 and decided to honor his native city of Paris. He used its old Roman name Lutecia, however, and came up with *lutetium*. Similarly, the Danish chemists Dirk Coster and Georg von Hevesey discovered ele-

In image of platinum crystal as revealed by field ion microscope, each dot is image of an atom of platinum, which looked like silver (Spanish *plata*) to its discoverer.

Photo courtesy Dr. E. W. Mueller, Pennsylvania State University



discoveries, scientific errors, patriotism — and human vanity

# f the Elements

ment 72 in 1923 and named it after Copenhagen, using the older name, Hafniae. Hence the birth of *hafnium*.

Scandinavian places are particularly well represented, for Swedish scientists have been unusually active in this type of research. But no place on earth is so materially honored as one small hamlet in Sweden. That is Ytterby, near which Gadolin found his fabulous mineral (which he named "yttria" in its honor). No less than four elements denote the town's existence. In 1843 the Swedish chemist Carl Gustav Mosander discovered elements 39, 65, and 68 in the mineral yttria, and they were eventually named *yttrium*, *terbium*, and *erbium*, in each case after Ytterby. Then, in 1907, Urbain (who also discovered lutetium) discovered element 70, now known as *ytterbium*. No need to guess where that came from.

Another little town, Strontian, in Scotland, has likewise been honored. A mineral discovered in a mine near there was dubbed "strontianite." In 1808 the British chemist Sir Humphrey Davy (who discovered more naturally occurring elements than any man who ever lived) isolated element 38 from that mineral and named it *strontium*.

Both a river and an island have been singled out for the periodic table. Three German chemists—Walter Noddack, Ida Tacke, and Otto Berg—discovered element 75 in 1925 and called it *rhenium* after the German Rhine River. Number 29, known from the earliest times, is called *copper*, a name that may be derived from the Mediterranean island of Cyprus, from which the Romans got their supply of that metal.

An ancient district in northeastern Greece, Magnesia, has been similarly honored. A white mineral found near it was known to the Greeks as "magnesia lithos" (Magnesian stone). A

black mineral with the power of attracting iron was also found near Magnesia and was therefore called "magnes" (from which our word "magnet" comes). Medieval alchemists confused another black material with this and misspelled "magnes" as "manganese." When element 25 was isolated from this second mineral by the Swedish chemist Johan Gottlieb Gahn in 1774, it was called just that, *manganese*. In 1808, Davy (the discoverer of strontium) located element 12 in the mineral and, although he called it "magnium" to avoid its being confused with manganese, it has come down to us as *magnesium*.

## Earth and Planets

All the place names, so far, are European. But when American chemists at the University of California, at Berkeley, manufactured number 95 in 1944, number 97 in 1949, and number 98 in 1950, they called them *americium*, *berkelium*, and *californium*. Actually, the United States had been honored on another occasion. Way back in the 1600's, Governor John Winthrop of Connecticut had added a rock fragment to his collection. His grandson sent the fragment to a scientist-friend in England, and in 1801 a British chemist, Charles Hatchett, discovered element 41 in the mineral and called it *columbium* for Columbia, a poetic name for the United States. By a curious coincidence, as we shall learn, this name was lost to posterity.

To top off the place-name elements, element 52—discovered in 1782 by the Austrian mining engineer Franz Joseph Muller—was eventually named *tellurium* after the Earth itself. (Tellus was the old Roman god of the Earth.)

Not all of the name-givers have been so Earth-bound. Element 34

was discovered by the Swedish chemist Jons Jacob Berzelius in 1818. Its properties were very like tellurium's. As tellurium was named for the Earth, Berzelius named the new element *selenium* for Earth's companion, the moon. (Selene was the Greek goddess of the moon.)

More dramatic is the case of element 2. During a solar eclipse in 1868, lines were observed in the solar spectrum unlike the lines of any element known on Earth. The British astronomer Sir Joseph Norman Lockyer attributed them to a new element he called *helium*, after Helios, the Greek god of the sun. It wasn't until 1895 that the same element was finally discovered on Earth.

Some elements and astronomical bodies were discovered nearly concurrently. The planet Uranus was discovered in 1781. When the German chemist Martin Heinrich Klaproth discovered element 92 in 1783, he called it *uranium* in honor of the new planet.

In like fashion, when the University of California group discovered (in 1940) the elements that come just after uranium in the periodic table, they named them for the planets discovered since Uranus. Number 93 was named *neptunium* for Neptune, number 94 *plutonium* for Pluto.

The first asteroids were discovered in 1801, and two of them were named Ceres and Pallas after ancient goddesses. When Klaproth, Berzelius, and a Swedish mineralogist named Wilhelm Hisinger discovered element 58 in 1803, it was therefore named cerium. And when a British physician, William Hyde Wollaston, discovered element 46 in the same year, he called it *palladium*. Element 80, *mercury*, also got its name from a planet. Known since ancient times, the element was named by medieval alchemists.

Some names have been inspired by mythological characters not associated, like these, with astronomical bodies. And in a few cases, the inspiration had a real reason behind it. For instance, the Swedish chemist Anders Gustaf Ekeberg discovered element 73 in 1802 and named it *tantalum* because he had been so tantalized by its elusiveness. (The word "tantalize" comes from the mythical character *Tantalus*, whose punishments in Hades included being made to stand in water up to his neck without being allowed to drink.)

### Solar Fire to Atomic Fire

A closely related element, number 41, had been named *columbium* just the year before, as we have seen. However, Wollaston (the discoverer of palladium) mistakenly thought columbium to be identical with tantalum. This erroneous opinion prevailed until 1844 when Berzelius (the discoverer of selenium) rediscovered element 41 and named it *niobium* after Niobe, the daughter of Tantalus. Niobium was adopted as the official name, and thus the New World lost its first recognition in the periodic table.

In recent years, Greek myths got one more play. In 1947 a group of American chemists at Oak Ridge—J. A. Marinsky, L. E. Clendenin, and C. D. Coryell—found element 61 among the products of uranium fission. They named it *promethium* after Prometheus, the Greek demigod who brought down solar fire (really

atomic fire, even if the Greeks didn't know that) to mankind.

Oddly enough, two elements pay homage to evil spirits. The medieval Saxon miners who came across minerals containing elements 27 and 28 found they couldn't handle them by the usual methods and considered them bewitched. When a Swedish chemist, Georg Brandt, isolated element 27 in 1737, he called it *cobalt* after "kobold," earth spirits in German folk tales. Another Swedish chemist, Alex Fredrik Cronstedt, discovered element 28 in 1751. It was called "kupfernicket," meaning "devil's copper." (We sometimes call the devil "Old Nick.") This was eventually shortened to *nickel*.

Quite a few elements are named after the minerals or other substances in which they are found. Davy consistently used this method of identification. In 1807 he discovered numbers 11 and 19. The first, occurring in a mineral known as "soda," was called *sodium*; the second, from a substance called "potash," was named *potassium*. In 1808 he discovered elements 20 and 56. The first occurs in limestone, for which the Latin name is "calx"; hence he named it *calcium*. Element 56 occurs in the mineral barytes, and it was called *barium*.

Two elements are named for their occurrence in gems. Berzelius discovered number 40 in the zircon, and so named it *zirconium*. That was in 1827. Earlier, in 1798, the French chemist Nicolas-Louis Vauquelin had

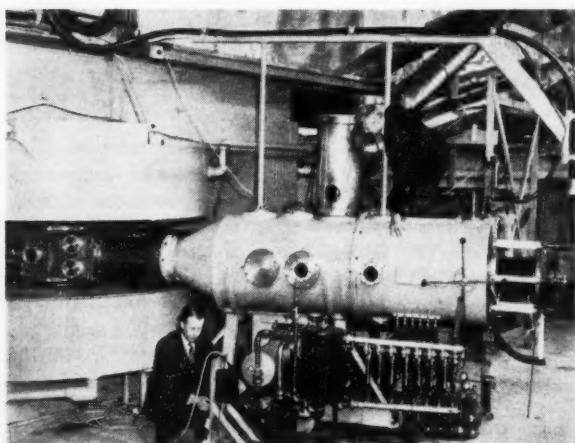
discovered number 4 in the beryl, and this element was eventually called *beryllium*.

More prosaic stuff is also honored. Ordinary coal is "carbo" in Latin. It is made up mostly of element 6, which is therefore called *carbon*. Similarly, the medieval alchemists, discovering element 33 in a mineral called "arsenicon," named the element *arsenic*. In more modern times, the French chemists Louis-Joseph Gay-Lussac and Louis-Jacques Thénard isolated element 5 from borax, so it was called *boron*. (Davy also discovered boron independently.)

### From Rocks to Rainbows

Element 83 is rather a puzzle, etymologically speaking. It was discovered in medieval times in a mineral called "weisse masse" (white substance). Some people think this phrase was corrupted into the modern *bismuth*. Element 74 is troublesome in another way. The Spanish chemists Fausto de Elhuyar and Juan Jose Elhuyar (they were brothers) detected it in the mineral wolframite in 1783, so it was named *wolfram*. Two years earlier, however, it had been detected by the Swedish chemist Carl Wilhelm Scheele in a Swedish rock called "tung sten" (heavy stone). The element is also called *tungsten* for that reason.

Three important gaseous elements have names ending in "gen." Element 1 was first studied scientifically by the British chemist Sir Henry Cav-



**Historic photo shows early cyclotron at U. of California at Berkeley with its inventor, Dr. Ernest O. Lawrence (bottom). In this atom smasher first synthetic elements were produced.**



**This is interior view of newest atom smasher at U. of California. Fragments of matter are hurled through "drift tube." A vacuum tank encloses course along which the particles speed.**

## How the other elements got their names

Element	No.	Date of discovery	Name and nationality of discoverer	Source of name	Element	No.	Date of discovery	Name and nationality of discoverer	Source of name
molybdenum	42	1781	P. J. Hjelm	(S) Found in what was thought to be lead ore (Greek for "lead": <i>molybdos</i> )	gallium	31	1875	L. de Boisbaudran (F)	From Gallia, the old Latin name for France
rhodium	45	1803	W. H. Wollaston	(B) From Greek word for "rose" (element forms rose-colored compounds)	francium	87	1939	M. Perey	(F) France
praseodymium	59	1885	A. von Welsbach	(A) From Greek words meaning "green twin" (forms green compounds and is like neodymium)	germanium	32	1886	C. A. Winkler	(G) Germany
neodymium	60	1885	A. von Welsbach	(A) From Greek for "new twin" (element is similar to praseodymium)	polonium	84	1898	M. Curie	(F) For her birthplace, Poland
chromium	24	1797	N-L. Vauquelin	(F) From Greek word for "color" (forms compounds of many colors)	ruthenium	44	1845	K. K. Klaus	(R) Ruthenia, old name for Russia
iridium	77	1804	S. Tennant	(B) From Greek word for "rainbow" (forms compounds of many colors)	europlum	63	1901	E-A. Demarçay	(F) Europe
actinium	89	1899	A. Debierne	(F) From Greek word for "ray" (element is radioactive)	titanium	22	1791	W. Gregor	(B) After the mythical giants, Titans
protactinium	91	1917	O. Hahn & Lise Meitner	(G) (A) From Greek word for "first," plus actinium (element breaks down into actinium)	thorium	90	1829	J. J. Berzelius	(S) After Thor, Norse god of storm and thunder
argon	18	1894	W. Ramsay and others	(B) From Greek word for "inert" (element is inert gas)	vanadium	23	1831	N. G. Sefström	(S) After Vanadis, Norse goddess of love and beauty
krypton	36	1898	W. Ramsay and others	(B) From Greek word for "hidden" (element was hard to get at)	silicon	14	1824	J. J. Berzelius	(S) From the Latin <i>silex</i> , "flint" (a substance in which the element is found)
xenon	54	1898	W. Ramsay and others	(B) From Greek word for "stranger" (element was hard to get at)	aluminum	13	1827	F. Wöhler	(G) Discovered in alum
neon	10	1898	W. Ramsay and others	(B) From Greek word for "new"	fluorine	9	1886	H. Moissan	(F) Occurs in the mineral fluorspar
antimony	51	Middle Ages	Unknown	Possibly from Greek "against solitude" (it readily reacts with other elements)	lithium	3	1817	J. A. Arfwedson	(S) From Greek word for "stone" (element exists only in mineral world)
holmium	67	1879	P. T. Cleve	(S) After Cleve's native city, Stockholm	zinc	30	Middle Ages	Unknown	Element probably confused with tin, known in German as <i>zinn</i>
thulium	69	1879	P. T. Cleve	(S) Thule, an old name for the Scandinavian northland	platinum	78	1748	A. de Ulloa	(Sp) Element looked like silver, known in Spanish as <i>plata</i>
scandium	21	1879	L. F. Nilson	(S) Scandinavia	cadmium	48	1817	F. Stromeyer	(G) Found in zinc compounds, known in Greek as <i>kadmeia</i>

A — Austrian; B — British; F — French; G — German; R — Russian; S — Swedish; Sp — Spanish

endish in 1790. It was christened *hydrogen* (from Greek words meaning "gives birth to water") because when it burns, water is formed. Element 7 was discovered by another British chemist, Daniel Rutherford, in 1772. Its name, *nitrogen*, means in Greek "gives birth to niter," and it does, in fact, occur in that mineral.

It is left to element 8 to strike the sour note. It was independently discovered by the British clergyman Joseph Priestley and by Scheele (the co-discoverer of tungsten) in 1774. Some years later it was named *oxygen* ("gives birth to sourness") by the French chemist Antoine-Laurent Lavoisier because he thought the element was an essential constituent of acids. The name left a sour taste in another way, for Lavoisier was mistaken. However, the name stuck.

There is a rainbow of color hidden in the names of the elements. Number 17 was proved to be an element by Davy in 1807. Since it is a greenish gas, it was named *chlorine* from the Greek word for "green." The French chemist Bernard Courtois discovered element 53 (chemically similar to chlorine) in seaweed ash in 1811. When heated, it became a beautiful violet vapor. It was named *iodine* from Greek for "violet."

A number of elements were discovered through their spectral lines, as helium was. The first to be so discovered (even before helium) were elements 55 and 37 in 1860 and 1861, by the German chemist Robert Wilhelm Bunsen and the German physicist Gustav Robert Kirchoff, who founded chemical spectroscopy. Element 55 was named *cesium* from the Latin word for "sky blue" and element 37, *rubidium*, from the Latin word for "red." Those were the colors of the lines they displayed. In the same year, the British physicist Sir William Crookes discovered element 81 and named it *thallium* (Latin for "green twig"). And two years later the German physicists Ferdinand Reich and Hieronymus Theodor Richter discovered element 49 and named it *indium*. The first showed a green line in its spectrum, the second an indigo line.

The radioactivity of certain elements has been a source of names. Radioactive elements give off rays, and the word "ray" is "radius" in Latin and "aktinos" in Greek. When

the Curies isolated element 88 in 1898, they named it *radium*. Then in 1900 the German physicist Friedrich Ernest Dorn discovered that radium produced a gas as it broke down. This gas, element 86, was eventually named *radon*.

Radioactive elements are also unstable. When the men at the University of California discovered element 85 in 1940, they called it *astatine* from the Greek word for "unstable." In the same year, they located element 43 among the products of uranium fission and called it *technetium* from the Greek word meaning "artificial."

### Emotions Play a Part

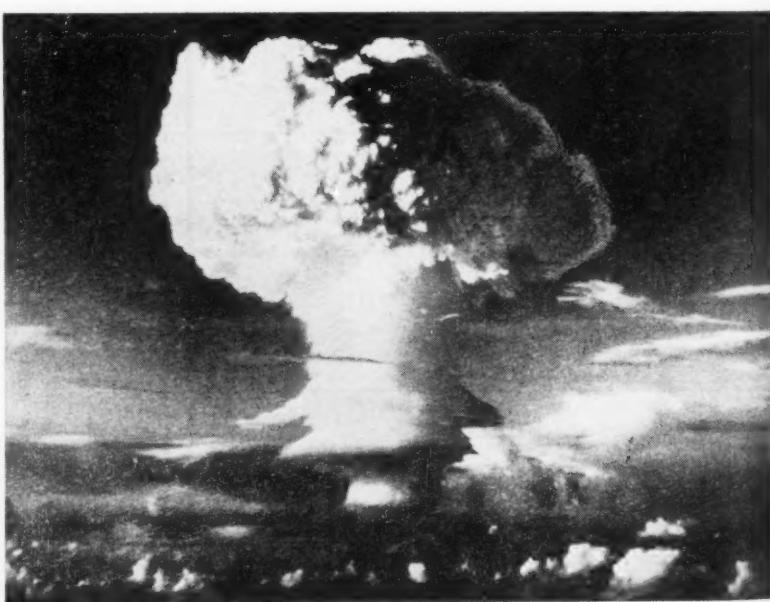
Long before radioactivity was known, another element was named for a mysterious property. In 1669 the German alchemist Hennig Brand discovered element 15 in urine. Since it glowed mysteriously in the dark (it was combining with oxygen, but Brand didn't know that), he called it *phosphorus* from Greek words meaning "light bringer."

Sometimes the names of elements betray a bit of the weariness of the job of discovery (as in the case of tantalum) and perhaps of the search for a name itself. For instance, in 1839 Mosander discovered element

57 and called it *lanthanum* from a Greek word meaning "to be concealed." (His later discoveries—erbium, terbium, and yttrium, which we've already mentioned—indicate a similar weariness.) In 1886 De Boisbaudran (who had earlier discovered gallium, gadolinium, and samarium) discovered element 66 and called it *dysprosium* from a Greek word meaning "hard to get at."

Two elements are named for their bad odor. Tennant (the discoverer of iridium) discovered element 76 in 1804. Its compound with oxygen is very foul-smelling, so he named the element *osmium* from the Greek word for "smell." Element 35—discovered in 1826 by the French chemist Antoine-Jerome Balard in the salts of evaporated sea water—is a red liquid with a strong, unpleasant odor. He named it *bromine* from the Greek word for "stench."

Our catalogue at this point leaves several elements with English names, which have been known since ancient times. These are elements 16, *sulfur*; 26, *iron*; 47, *silver*; 50, *tin*; 79, *gold*; and 82, *lead*. With them, the list of the 102 names (and a couple to spare) is complete. At least for now, for one should never bet against future entries. Element 103, for instance, may be just around the corner!



Wide World photo

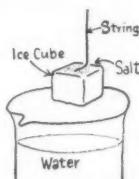
**Element 99 (einsteinium) and element 100 (fermium) were first found in debris of radioactive cloud produced by atomic explosion in South Pacific in November 1952.**

## The Processes of Science

# WHY?

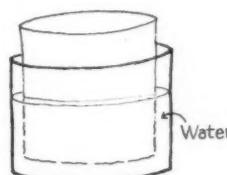
By THEODORE BENJAMIN

1. Float an ice cube in a beaker of water. Get a short length of cotton string and moisten it thoroughly. Lower the string so that one end rests on the surface of the ice cube. Hold the other end. With the string in this position, sprinkle a little table salt on either side of the string where it rests on the ice cube. Wait about 10 seconds, then lift the string. You will be able to lift the cube from the water. Why?

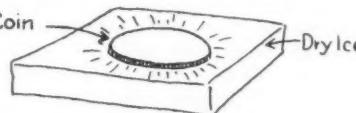


2. Archimede's principle implies that a floating body displaces a weight of fluid equal to its own weight in air. Can an object float in less than its own weight of water? Get two containers of almost the same size, so that the smaller fits freely into the larger, but with a small space between them. Now load the smaller container with coins so that it floats deep in water. Weigh the con-

tainer and its load. Place a small amount of water (which weighs less than the small, loaded container) into the larger container. The loaded container will float in the relatively small amount of water in the larger container. Why?

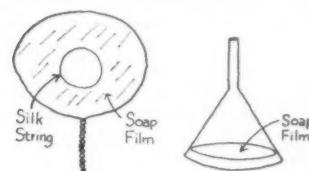


3. Place a flat piece of "dry ice" (solid carbon dioxide) on a table. Press a coin, such as a quarter, flat against the surface of the dry ice. The coin will vibrate vigorously for a few moments, emitting a high-pitched squeal until it cools down to the temperature of the dry ice. Why?

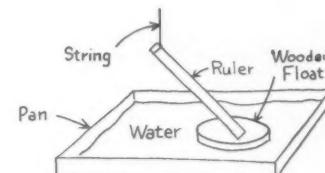


4. Using stiff wire, make a ring about 5 inches in diameter. Twist the wire so

a handle is formed by which you can hold the ring. Now make a loop in one end of a piece of fine silk thread and attach it so that it hangs inside the ring. Dip the ring in a soap solution so that a soap film is formed on it. Puncture the film *inside the loop of thread* and it will immediately form a circle. Why?



5. Hang a 12-inch ruler by a thread attached to one end. Rest the lower end of the ruler on a wooden float in a pan of water. The stick may be inclined at any angle but when equilibrium is reached, the thread is always vertical. Why?



6. The rather unusual element gadolinium is a magnetic substance. If a button-shaped disk of pure gadolinium is placed on the table, it can readily be picked up by a magnet. If, however, the disk is held in the hand, it will not be picked up by a magnet. Why?

### Answers

1. You may have observed the way in which rock salt thrown on ice will melt the ice, provided the temperature is not too far below 32°F. Salt water has a lower freezing point than pure water. The salt in contact with the ice causes the ice to melt. As the salt melts the ice, the ice must obtain heat in order to change its state. It therefore absorbs heat from the adjacent ice and the water on the string, causing the latter to freeze and adhere to the ice cube.

2. Yes, the smaller container will float even though it is floating in a volume of water whose weight is less than its own. Archimedes' principle does not refer to the weight of the water which surrounds the floating object. It refers to the weight of the water which *would* replace a volume equal to that portion of the floating object immersed in the water. In this case, despite the small amount of water surrounding the inner can, the water

rises so high that if the volume displaced were filled with water, it would weigh what the smaller can weighs.

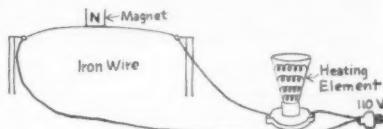
3. As the relatively warm coin contacts the dry ice, the gaseous carbon dioxide, which is formed and trapped under the coin, lifts the coin. As soon as the coin is thus lifted, the gas escapes and the coin is again allowed to contact the surface. The process, repeated rapidly, causes the coin to vibrate and emit the characteristic sound.

4. The surface tension of the soap film always acts to decrease the surface area of the film. The film outside the loop contracts to form the minimum area. You can see the effects of this contraction if you dip the mouth of a glass funnel into soap solution and withdraw the funnel so that a soap film covers the funnel. The film formed across the open mouth of the funnel rises toward the narrow end of the funnel.

5. If the thread hangs at any angle other than the vertical, there will be a

horizontal component of force on the float, and the float will move until no such component exists. This is possible only if the string is vertical.

6. All magnetic substances have a temperature above which they lose their magnetic properties. This is called the *Curie point*. You can demonstrate the point at which iron loses its magnetic properties by assembling the apparatus shown below. As current is sent through the iron wire held in an upward bow by the magnet, the wire will begin to become hot. Shortly after the wire glows red hot, the wire will fall away. The Curie point for iron is about 750°C., for gadolinium, 33°C. Thus gadolinium held in the hand (body temperature, 37°C.) will not be attracted by magnet.



# Science in the news

## Nobel Medical Prize

Two scientists—working on opposite sides of the globe—have been awarded the 1960 Nobel Prize in Medicine for their work on a theory of immunity, which some day may lead to the transplantation of human organs from one person to another.

The two researchers, who share the honors and \$43,000 in prize money, are Dr. Peter Medawar, professor of zoology and comparative anatomy at University College, London, and Sir Macfarlane Burnet, director of the Walter and Eliza Hall Institute for Medical Research in Melbourne, Australia.

The Nobel Prizes are awarded from a fund bequeathed by Alfred B. Nobel, inventor of dynamite, who died in 1896. They are given annually to those people who have most benefited mankind in the sciences, literature, and diplomacy during the preceding year, without regard to nationality.

The award-winning scientists developed a theory on the process of immunity. This is the process by which the body of an animal or human being produces so-called antibodies which attack invading organisms. Immunity provides protection against invading microorganisms, but it also prevents the transplantation of tissue from one body to another. The grafted foreign tissue usually dies and is sloughed off as a foreign body.

This makes it very difficult to replace defective organs in one body with similar healthy organs from another body—except in the case of identical twins.

Dr. Burnet, who discovered a vaccine which gives immunity against influenza, theorized that the ability of the body to reject foreign substances develops gradually as the embryo grows. This suggests that if a foreign tissue were introduced into the embryo, immunity to this tissue would not be built up. Thus similar tissues would not be repelled later in life.

This theory was checked in London by Dr. Medawar and his co-workers. They inoculated mouse embryos with tissues from a different breed of mice. After the embryos had developed into full-grown mice, tissues from the different breed were grafted on to them. The grafts held, and the foreign tissue lived after transplantation, which would not normally be the case. A further check showed that animals which had not received such inoculations while in the embryonic stage cast off the grafts. This means that Dr. Burnet's theory was correct and that a body can be made to tolerate foreign tissues.

There are as yet no practical applications of this theory. But the day may come when it will make possible the transfer of lungs, hearts, or limbs from one human body to another, or perhaps even from one species to another.



THE THEORIST: Australian scientist Frank Macfarlane Burnet, who won Nobel prize in medicine for his theory on immunity.



THE EXPERIMENTER: British researcher Peter Bryant Medawar, who shared prize for his verification of Burnet's theory.



UPI photo  
Wave length of orange-red light glowing from krypton-86 lamp replaces standard meter. Lamp operates in liquid nitrogen.

## New Length Standard

The world adopted a new international standard of length this month, based on the wave length of light.

The new standard will replace the platinum-iridium meter bar which has been kept at Paris as an international standard of length since the Treaty of the Meter was signed by many nations in 1889.

Unlike the platinum-iridium bar, there is nothing tangible about the new standard, which is simply a measure of the wave length of light. Light consists of continuous and regular waves of electromagnetic energy which radiate from the source of light. The distance between two successive waves is known as the wave length, which determines the color of the light. As far as scientists know, this wave length never changes—and is the same everywhere on Earth and in the universe.

The new standard of length defines the meter as 1,650,763.73 wave lengths of the orange-red line in the spectrum of the gas krypton 86. Krypton 86 is an artificially created isotope of the gas krypton, which is found in the air.

Until this new standard was devel-

oped, the world had to rely on a material standard of length—the distance between two engraved lines on the international meter bar kept in the vaults of the International Bureau of Weights and Measures in Paris. Duplicates of this standard were maintained in standards laboratories of other countries.

From time to time, these secondary standards had to be returned to Paris for calibration. Also, there were doubts in the minds of many scientists regarding the stability of the metal of which the meter bar was made.

By contrast, the new definition relates the length of the meter to a universal and unchangeable constant of nature, which can be reproduced with great accuracy in any well-equipped laboratory.

The new standard will not change the measurement of length or the relation between the English and Metric units, since the wave length standard is almost exactly equal in length to the metal standard. The inch now is equal to 41,929.399 wave lengths of the krypton light. The difference between the new standard and the old standard is incredibly small. Measurement by the light standard would shorten the distance from Washington to New York by less than three inches. However, this extremely slight shortening will bring the length of the meter into agreement with measurements commonly used in many branches of science.

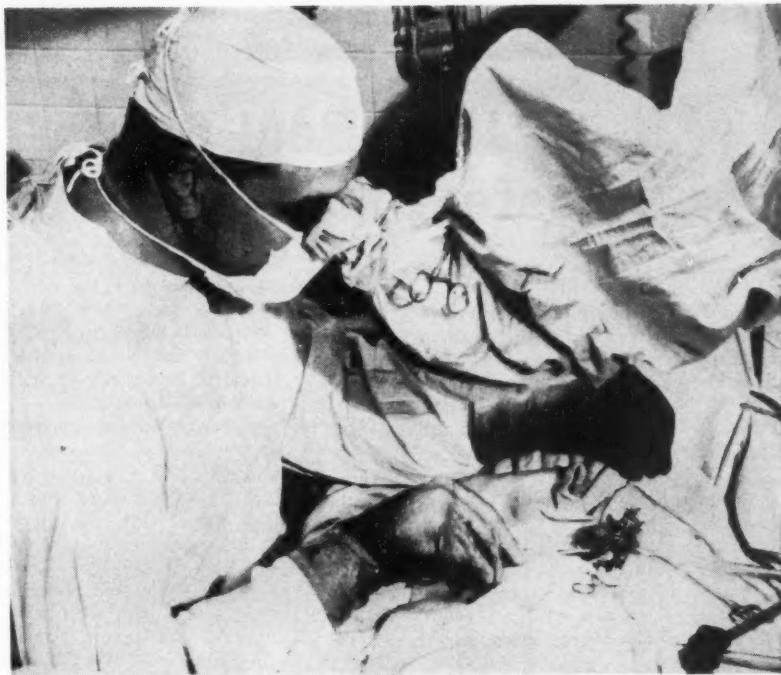
## Atomic Centrifuge

The balance of power among the nations of the world may change drastically within the next decade.

This would result from a recently perfected, inexpensive process of producing uranium-235—the fuel for nuclear reactors and the material used in atomic bombs. This cheap method of producing U-235 may permit many smaller nations to develop nuclear bombs.

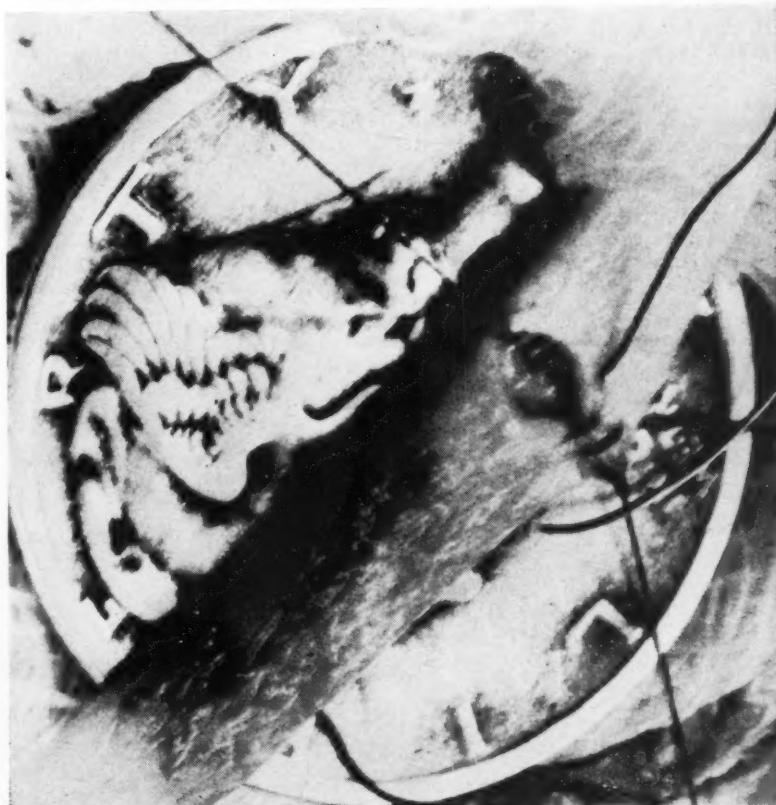
Natural uranium contains abundant quantities of uranium-238, and much smaller quantities of the fissionable isotope uranium-235, which is required for a nuclear reaction. Until now, the uranium-235 was separated from the uranium-238 by the very expensive gaseous diffusion process. In this process uranium in gaseous form is pumped through thousands of sub-microscopic sieves that separate the two isotopes.

Recently, however, a process using the principle of the centrifuge has been developed. In the centrifuge process, the uranium gas atoms are whirled around in a cylinder. As they spin, the centrifugal force moves the heavier atoms of uranium-238 toward the outside of the cylinder, thus separating the isotope.



American Heart Association photos

**Every surgeon must be very skillful at sewing tiny blood vessels during an operation, but Dr. Julius H. Jacobson II (above) of the University of Vermont felt that skill was not enough. Using a stereoscopic microscope and a jeweler's miniature tweezers, he developed a technique of microsurgery which allows him to operate on blood vessels no thicker than a toothpick. In photo below, a dime is used for size comparison.**





## Dr. John Paul Stapp— Fastest Man on Earth

### WHOOOOSH! SLAM!

That's how the most famous sled rider in history crashed into the center of world attention about six years ago. He is Colonel John Paul Stapp of the U. S. Air Force's Aero-Medicine School at Brooke Army Medical Center in San Antonio, Texas.

The "whoosh" was Colonel Stapp's ride on a rocket-powered sled at Holloman Air Development Center, New Mexico, on December 10, 1954. Roaring along a railroad track, Stapp hit a top speed of 937 feet per second—faster than the flight of a .45-calibre bullet—and a new world speed record for land travel.

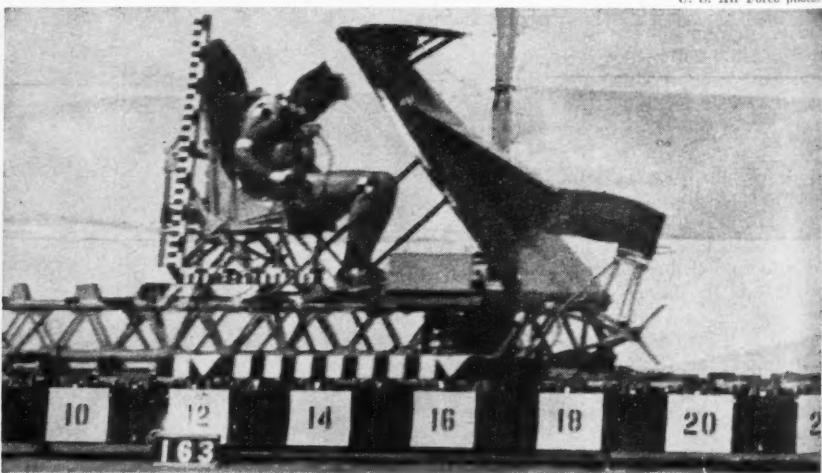
The "SLAM" came at the end of the six-second ride. The sled braked from top speed to a dead stop in 1.4 seconds. The terrific jolt subjected Stapp to a deceleration force of 40 "g's" (40 times the force of gravity)—about the same impact you'd get by driving a car at 120 mph into a brick wall.

The "human decelerator" was a 1,500-pound carriage mounted on a 3,500-foot stretch of standard-gauge railroad track. Four "grippers" secured the carriage to the rails, but permitted it to slide freely. Nine rockets at the rear of the carriage provided thrust. The sled was decelerated by bucket-shaped scoops underneath, designed to dig into water placed between the tracks near the end of the line.

In early experiments, Stapp used rocket sled decelerated by 45 sets of friction brakes installed on roadbed (photos below). In later experiments, sled was slowed down by scoops.

These dug into water-filled trough placed between the rails.

U. S. Air Force photos



thought it was. Stapp believed that not only was the human body stronger than generally thought, but that given properly-built seats, cockpits and straps, humans could survive any crash if the plane did not completely break up.

Nine rockets accelerated the sled to 937 feet per second before they burned out. It had taken only five seconds to bring Stapp and his sled up to nine tenths of the speed of sound. Even this comparatively mild acceleration (over 6 g) can produce a brief visual blackout. Visual blackout and loss of consciousness are caused by a decrease in the supply of blood to the brain and eyes. The rhythmic action of the body's blood-pumping mechanism is interrupted by the strain of the g forces.

The sled coasted for half a second after reaching top speed. Then the scoops underneath it dug into the water between the rails, bringing Stapp to a complete stop in 1.4 seconds. He had experienced momentary peaks of up to 40 g; and he had withstood 25 or more g for 1.1 seconds. (In other runs, Stapp has withstood peaks of up to 45 g.)

Stapp's body was bruised by the straps, and flying grains of sand raised minor blood blisters. When the sled hit the water brakes, Stapp's vision became (in his words) a "shimmering salmon," followed by "a sensation in the eyes . . . somewhat like the extraction of a molar without an anesthetic." He was blind for 8½ minutes, and he walked around with black eyes for a few weeks, but he suffered no permanent damage to his eyes or to any other part of his body. Stapp concluded that at this speed and deceleration, the effects of the windblast (which reached a respectable 1,100 pounds per square foot) were negligible compared with effects caused by deceleration alone.

Stapp's shiners were caused by his eyeballs shooting forward in their sockets and breaking the small blood vessels.

(Continued on page 29)

## PROJECTS AND EXPERIMENTS

# tomorrow's scientists



## PROJECT: My Experiences With Spiders

STUDENT: DAVID FEARS, GRADE 11, WINNER, FUTURE SCIENTISTS OF AMERICA AWARDS

SCHOOL: CLEVELAND HIGH SCHOOL, PORTLAND, OREG. TEACHER: MISS LEONA TODD

[The world of life is a world of motion. Organisms and the cells of which they are composed are in constant motion. It is the restlessness of protoplasm, perhaps, more than any other single characteristic, that distinguishes living things from non-living.

The movement of protoplasm is an expression of its ability to react to stimuli. A stimulus may be some signal from the environment outside the organism, or from some chemical or physical change within the organism itself—the internal environment.

Which stimuli cause specific responses? What functions do the characteristic responses of animals perform? The curious person who puts these questions to nature opens the door to many fascinating and rewarding experiences. But getting the answer to these questions often requires patience plus a generous helping of good old-fashioned "Yankee" ingenuity. With these qualities and some inexpensive homemade equipment, David Fears was able to make some discoveries about the behavior of spiders.]

### DAVID'S PROJECT

My interest in spiders began when I noticed a spider on my window, one day, as it was spinning its irregular maze-like web. I watched the creature closely, observing its every action. Little did I know that this was to be the start of a long period of study and experimentation on these "miraculous" little engineers. In the first few months of collecting specimens, I merely tried to keep them alive. It was soon evident that they had to be kept in separate containers because they are natural cannibals.

I also learned how each species differs from others and how each does things differently. There are several types of webs and numerous ways of

capturing prey among the various species. Each species of spider has different hiding places. I soon learned how and where to collect each species.

Classification was one of the biggest problems I have had to face. At first, I was really in a muddle. My teacher helped me some, and for a few weeks I struggled along. Soon it became easier, and before I knew it, I had placed most of the spiders I had collected in their proper genera.

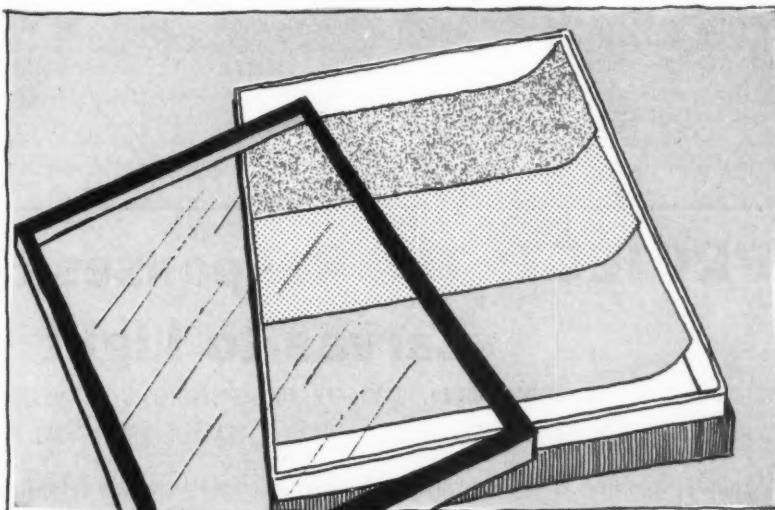
As winter approached, I was faced with another problem. I had collected enough specimens to last the winter, but the food supply was running low and only a few insects were to be found. I solved the problem by raising fruit flies which multiplied fast enough to supply the needs of all my captives. The spider's ability to go for days at a time without food was also helpful.

As soon as this problem was solved,

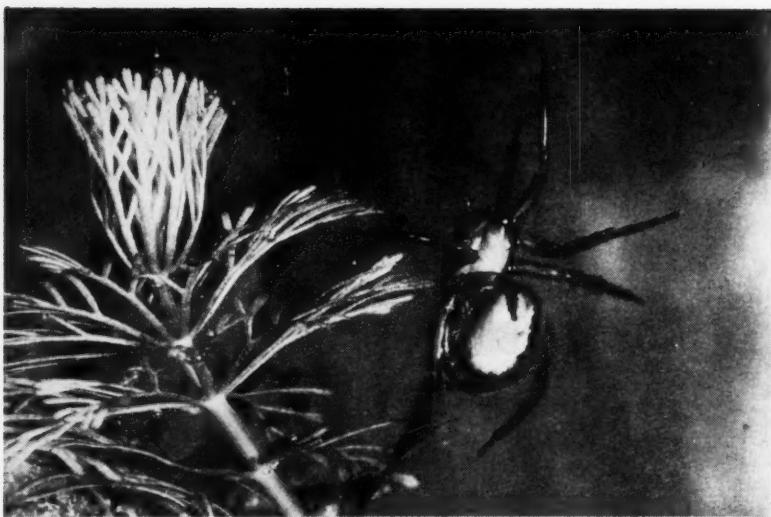
another took its place. A captive female specimen, which I eventually kept alive for 195 days, had made an egg sac. In the following week, the young spiders emerged—all 112 of them.

I decided to see if it was possible to keep all of the young spiders in the same jar until they got a little larger. The young ate each other despite my efforts to satisfy their hunger. In a matter of weeks only one fat spider (besides the mother) was left.

When another egg sac was produced by another female, I tried a new approach to the problem of keeping young spiders alive during their early stages of development. I fed the young heavily for a week on water and fruit flies. Over half survived in the same jar. Then they were released in a vacant part of my basement. This plan also provided a collecting ground for mature specimens.



Glass-topped box lined with strips of different colored paper was used to test spiders' color vision. Preference was determined by number of times spider moved to color.



Walt Disney Productions

**David Fears is interested in adaptations and behavior of spiders. This diving spider builds her nest underwater and supplies it with air bubbles carried from the surface.**

#### Color Vision Experiment

While I was working with classification, I read of an interesting experiment on the color vision and color preference of spiders. The scientists who did this experiment built a cage of colored glass with red, yellow, green, and blue compartments. The compartments were constructed so that the spider had free communication from compartment to compartment. When a spider came to rest, the color he stopped on was recorded. The spider was then disturbed and made to choose its resting place again. From time to time the cage was cleaned of all threads of silk, and the order or the width of the colors was changed. The scientists found spiders choose red (181 times) more often than yellow (32 times), green (13 times), or blue (11 times).

The spiders used in the experiment were wolf spiders. It is generally agreed that the jumping spider has superior eyesight, so I decided to carry out a

similar experiment with jumping spiders.

Instead of colored glass and compartments, I used a box with a glass cover and strips of colored paper: red, yellow, green, and blue. On the bottom and sides of the box, I placed two strips of paper, each of a different color. I could observe the behavior of the jumping spider as it walked upside down on the inside of the glass top of the observation box. Since the jumping spider's eyes are on the top of its *cephalothorax* (head plus thorax), it looked down at the colored strips. I recorded the number of times the spider moved toward each color.

Each test was limited to 15 minutes. The observations were carried out over a three-month period to make sure my results indicated a tendency of the spider to move toward a color, and not random choices.

My final results brought a number of general and specific conclusions. In general, it can be said that the spider prefers the brighter colors, and the

order of preference is red, yellow, green, and blue. When placed between red and blue, the spiders showed a 90 per cent tendency to move towards red. Between red and green, there was also a 90 per cent tendency for red. There was no preference shown between green and blue nor between green and yellow. Between yellow and blue, however, there was a 70 per cent preference for yellow. To confirm these results, the experiments will have to be repeated many times with different specimens and different species. Whether the spiders recognized the lanes as colors, or recognized them as different shades of black and white, I could not determine.

#### Collecting New Species

There are many different habitats for spiders in the neighborhood. I made an all-out effort to find species I had not collected before. My reward was two new varieties, one of which I classified right away. The second species contradicted the keys which indicate these spiders are not found in Oregon.

After this I started receiving specimens from outside the local area. These included several female black widows and one tarantula, also a female. I studied these in much the same way that I had studied all the local species when I started work.

During this time I also started a study on the embryology and juvenile stages of spiders. Several times I have removed the eggs from an egg sac and placed them in the end of a test tube with a cotton plug pushed up against them. This enabled me to study the various stages of development of the egg.

My project has grown from learning by reading and observation to learning by experimentation. I have many plans for continuation of my work and am very anxious for the collecting season to arrive so I can continue color vision experiments.

## PROJECT: The Responses of Mosquito Larvae to Light

**STUDENT: RONALD WEINTRAUB, GRADE 10, WINNER, FUTURE SCIENTISTS OF AMERICA AWARDS  
SCHOOL: FREDERICK HIGH SCHOOL, FREDERICK, MD. TEACHER: MRS. AUDREY PRESSLER**

Ronald Weintraub was also interested in the movements of animals. In contrast to David's general interest in spiders, Ronald focused on a single

stimulus-response relation. He wondered what effect changing the intensity of light would have on the surfacing and diving movements of mosquito larvae.

A careful study of these two projects points out a basic axiom or rule to be followed in animal experimentation of all kinds: Before anyone undertakes to

reen, red, or yellow per cent. There also exists a difference between the two and how they differ. The results are to be different in the methanes as different in the light.

Ronald begins his project with a brief description of larvae of *Aedes aegypti*.

### RONALD'S PROJECT

Mosquitoes undergo a series of changes in their life cycles. The egg hatches into a larva which goes through four molts, or instars, before being transformed into a pupa, which in turn gives rise to the adult or *imago*.

The larvae, or "wrigglers," of the genus *Aedes* are very active. They are aquatic animals that swim with sudden jerks of the body that produce a wriggling motion. Both larvae and pupae are air breathers primarily, and must spend a considerable amount of time hanging from the surface film of the water, breathing through special air tubes or siphons. The larvae feed by sweeping their food into their mouths with organs called mouth brushes.

The specific gravity of the *Aedes* larva is less than that of water. Therefore, it can float up to the surface, but must swim down.

Larvae and pupae when at the surface will react to mechanical agitation of the water or to shadows by diving rapidly to the bottom. Apparently this is a protective adaptation against potential danger.

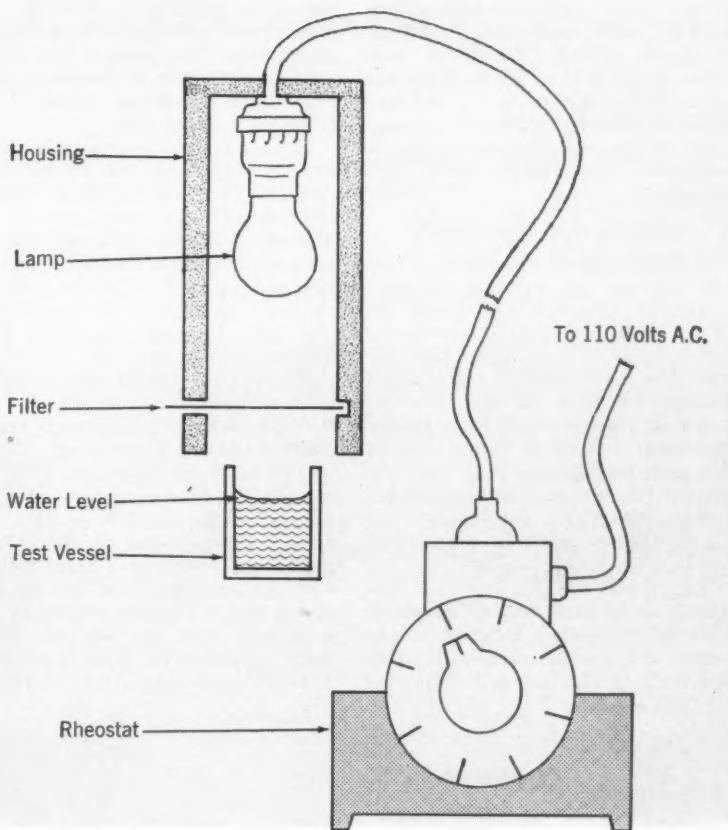
The following observations apply only to *Aedes aegypti*. Larvae of other species may behave differently.

When the larvae are illuminated from above, the diving response is induced not only by shadows but also by small decreases or increases in the intensity of the illumination. Since the movement is downward (whether the light is increased or decreased) the change in intensity appears to trigger a geotactic response (a response to gravity).

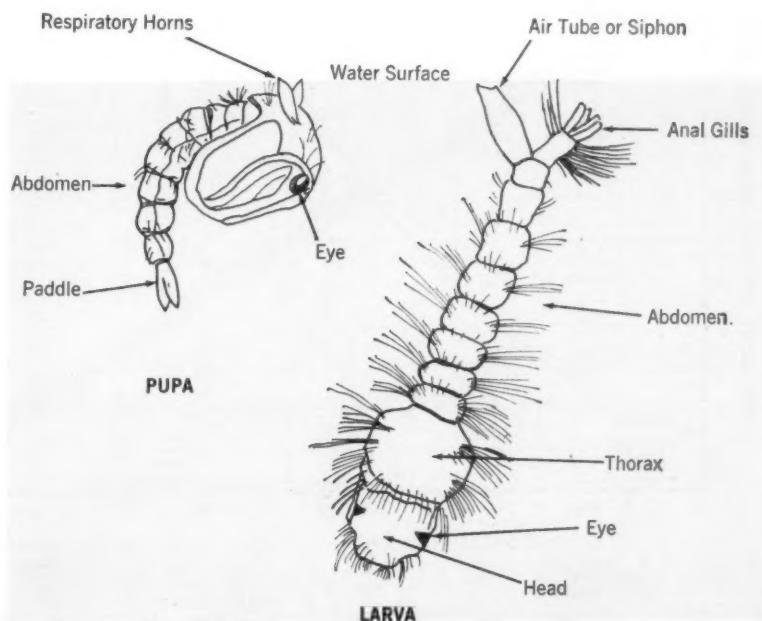
When illuminated from the side, a change (either increase or decrease) in intensity induces the diving reaction, but the larvae tend to move away from the source at the same time and to descend in an arc.

When illuminated from below, a decrease in intensity causes diving. An increase in intensity, however, causes violent motion of the larvae at the surface without diving. The larvae below the surface at the time of stimulation swim at once to the surface.

Eggs of *Aedes aegypti* were hatched



In experiments on mosquito larvae's responses to changing light intensities, Ronald used equipment above. Rheostat permitted light intensity to be controlled precisely.



Sketches show larval and pupal stages of mosquito, *Aedes aegypti*. Both stages are aquatic. Insects must come to surface to breathe through special respiratory organs.

Ronald Weintraub

in water deoxygenated by boiling. The resulting larvae were used as the experimental animals. The larvae were grown in small glass jars or large test tubes at room temperature in ordinary daylight. Pulverized dog meal was supplied as food. All illumination experiments were carried on in a dimly lighted room.

#### Methods and Experiments

A 50- or 60-watt incandescent lamp was used as the experimental light source. To eliminate stray light, the lamp was housed in a light-proof box with a  $2\frac{1}{2}$ -inch square hole in the bottom. A piece of white cardboard was interposed between the lamp and the test vessel to serve as a neutral filter. The filter transmitted 3 per cent of the available illumination. This was measured by means of a Weston illumination meter with a 4-inch scale reading to 500 foot candles (each division representing 5 foot candles).

The intensity of the light was controlled by a rheostat, and calibrated with the illumination meter. A remote control lever was attached to the rheostat knob so that it could be turned

through any predetermined angle while keeping the larvae under uninterrupted observation. The rheostat was placed on a separate table so that its manipulation did not result in mechanical agitation of the test vessel.

To measure the response, about ten animals were placed in a 3.5 cm. diameter vial filled with water to a depth of 4 cm. Counts were made of the number of larvae at the surface, just prior to stimulation, and of the number responding. After sufficient time for recovery, the stimulation was repeated. This procedure was repeated five to fifteen times for each vial. The entire procedure was then repeated with a different intensity of stimulus, so that the generalizations represent experiments with 50 or more larvae.

Because *Aedes* larvae are relatively active under constant conditions, a correction had to be made for this. The correction was found by taking large numbers of counts at a given interval with constant conditions. The per cent diving under constant conditions was subtracted from the per cent diving under experimental light stimulation. A background illumination of 16 foot

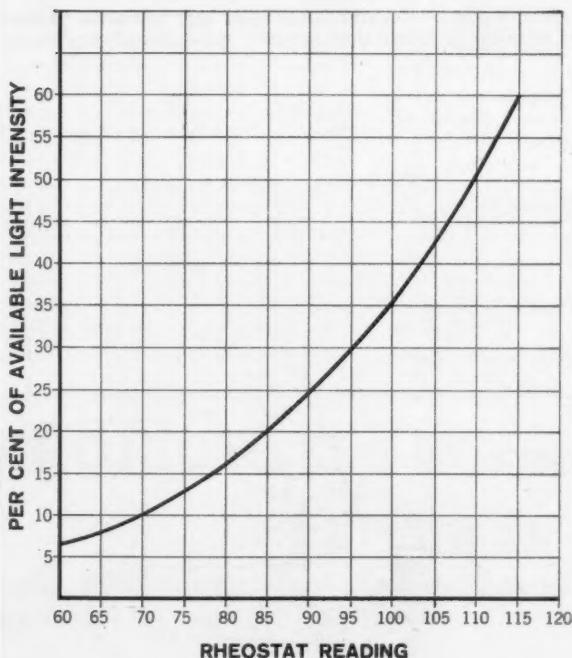
candles was used throughout the experiment.

#### Results and Discussion

Comparisons were made of larvae of three sizes (3 mm., 4 mm., and 7-8 mm.), which presumably represent second, third, and fourth instars, respectively. In each case, a straight-line relationship between response and change of intensity was found. The larger the larvae, the greater the response. Sensitivity also increased with increasing size of the larvae. It cannot be determined from the present experiment whether sensitivity increases continuously with development or takes successive jumps with each molt. To clarify this, a single batch of larvae should be used to determine sensitivity at successive stages of development.

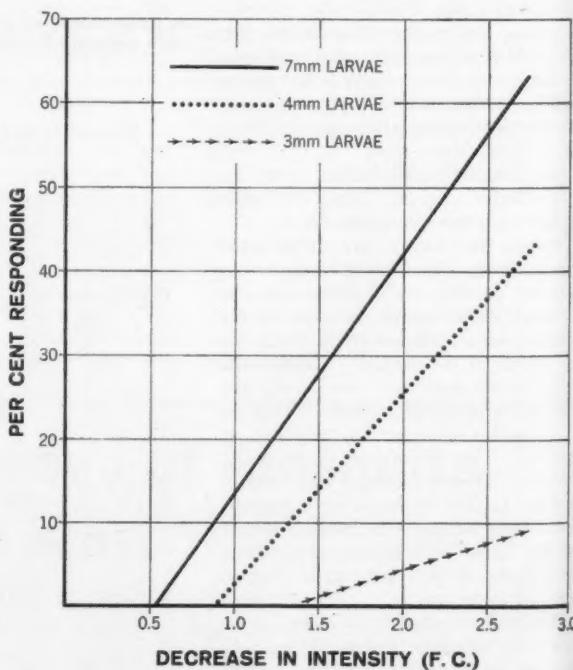
The reported experiment does not establish whether the illumination intensity required to cause a response is constant at all values of background illumination, or varies with the latter. In a preliminary experiment to check this, I found responses to be nearly the same with background lighting ranging from 4 foot candles to 20 foot candles.

#### CALIBRATING THE RHEOSTAT



So that same light intensity could be duplicated several times, rheostat dial readings were calibrated against available light measured with light meter. Calibration curve is shown above.

#### RESPONSES OF MOSQUITO LARVA TO DECREASING LIGHT INTENSITY



Ronald Weintraub

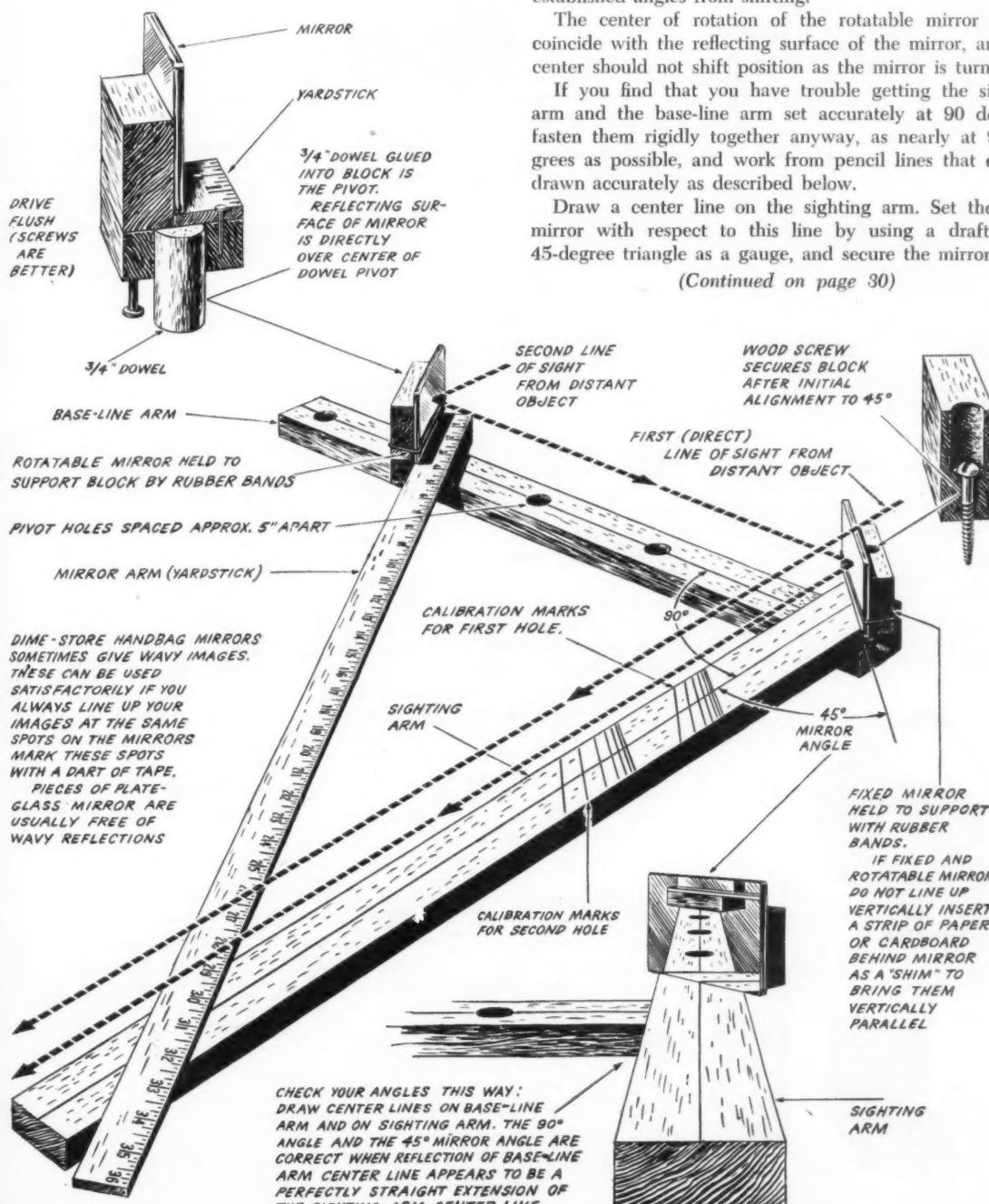
Curves above show how larvae at different stages of development respond to decreasing intensity of light. Note that older larvae responded more quickly to smaller changes.

# PROJECT POINTERS

## Optical Range Finder

One basic form of range finder is shown below. You may find it convenient to modify details. In doing this, remember the following important features:

The fixed mirror must be accurately set at 45 degrees with respect to the sighting arm.



By ALEXANDER JOSEPH

The base-line arm should be accurately set at 90 degrees with respect to the sighting arm.

The mirror arm should be parallel to the face of the movable mirror.

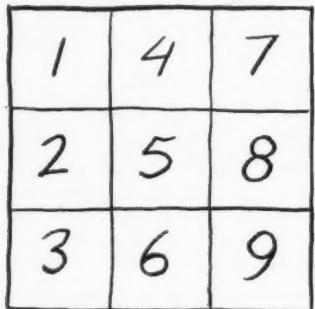
The structure must be substantial enough to keep the established angles from shifting.

The center of rotation of the rotatable mirror should coincide with the reflecting surface of the mirror, and this center should not shift position as the mirror is turned.

If you find that you have trouble getting the sighting arm and the base-line arm set accurately at 90 degrees, fasten them rigidly together anyway, as nearly at 90 degrees as possible, and work from pencil lines that can be drawn accurately as described below.

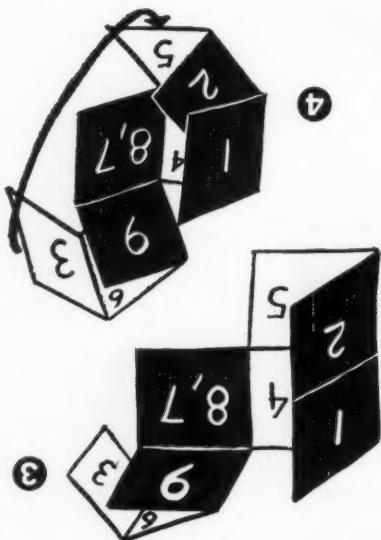
Draw a center line on the sighting arm. Set the fixed mirror with respect to this line by using a draftsman's 45-degree triangle as a gauge, and secure the mirror block

(Continued on page 30)

**Puzzle Cube**

This little puzzle is easy to solve if you have sufficient ingenuity. Take a piece of paper which is black on one side and white on the other and cut a square from it, say three inches on a side. Draw four lines so as to divide this square into nine equal squares, one inch on a side, and number the squares as in the drawing above. The problem is to find out whether it is possible to cut and fold the paper along the lines drawn so as to form a cube which is completely black. Any combination of cuts and folds can be used as long as they are done on the lines and none of the small squares are removed.

*Dave Helphrey  
Spokane, Washington*



*Answer:* There are many possible solutions to this problem, one of which is given here: Cut the square along the heavy lines shown in Fig. 1. Fold square 3 over square 7, so that squares 3, 6, 9, and 8 are turned over as shown in Fig. 2. Then fold as shown in Figs. 3 & 4 to form the required cube. Different cuts and folds form different cubes. Try to find the solution which fits the requirements of the problem with the minimum number of cuts and folds.

**Sir Walter's Wager**

There's an old tale about Sir Walter Raleigh which states that he once wagered that he could find out exactly how much smoke there was in a pound of tobacco. People scoffed, believing it would be impossible to measure the weight of something as airy as smoke. Nevertheless, Sir Walter won his wager by following a very simple procedure. Can you deduce what it was?

*Suzie Rattaro  
St. Anne's School  
San Francisco, Calif.*

*Answer:* He smoked a pound of tobacco, carefully saving all the ashes. Then he weighed the ashes and one pound gave him the difference between the weight of the ashes and one pound. The difference was to how much smoke there actually was in one pound of tobacco.

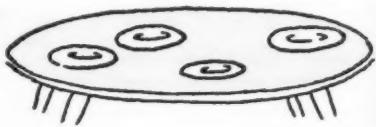
**Do you have a favorite brain teaser? Send it to Science World, 33 West 42nd Street, New York 36, N. Y. We will pay five dollars for each one published. Include the name of your school, home address, grade, and age.**

**Table Setting**

Imagine that you and a friend of yours are to play a new type of game. The object of this game is to cover a round, square, or rectangular table with dishes by placing them one by one on the table. You and your friend are to place the dishes alternately, one by one, on the table. The dishes must be all of one size.

According to the rules, a dish can be placed on any uncovered part of the table as long as it does not fall off. The winner of the game is the person who places the last dish on the table, after which no more dishes can be placed. To make sure that you are the winner, would you want to be first or second to place a dish on the table?

*Brenda Kreidler  
Slatington H.S.  
Slatington, Pa.*



*Answer:* In playing this game, you can win every time if you go first and place your first dish in the center of the table. Then, wherever your friend places directly opposite his, you place your next dish directly opposite hers, so on until you must place the last dish and that you win the game.

**Answers to Crossword Puzzle**

(see page 31)

AIR	WATER	PHD
GROS	TIN	XRAY
EOSINE	SEINE	
NITON	PINSK	
PNEON	ATOM	M
EMSKY	SONHE	
TAR		FAT
ATGAS	MNSLA	
LIMICA	HEWNL	
DEVIL	OLEIC	
DOSED	PLETHE	
ODOR	IONPRAY	
TON	RADONE	ENE

Spartan School of Aeronautics

Spartan School of Aeronautics

## Fastest Man

(Continued from page 22)

vessels and microscopic capillaries in his eyelids and around his eyes. In the course of his tests, Stapp also experienced several retinal hemorrhages, in which the blood vessels of the eye itself break and allow blood to flow into the liquid (aqueous humor) filling the eye. This may produce partial or total blindness, but usually is temporary.

G forces also may cause small measles-like spots to appear in the skin as a result of blood being forced out through the capillaries near the skin's surface.

During his rocket sled rides, Stapp also experienced mild degrees of concussion, a condition usually produced by a sharp blow to the head. Its symptoms are a weak pulse, slow respiration and, usually, unconsciousness.

Other scientists are studying the possibility of submerging astronauts in water to reduce the effects of g forces. They are testing this possibility through the use of the centrifuge. Archimedes was the first to notice that a body immersed in fluid loses a portion of its weight equal to the weight of the fluid it displaces. With this in mind, it has sometimes been assumed that a space traveler immersed in water would be effectively weightless and therefore immune to all g forces, having no weight to be increased by the acceleration.

Actually, things are more complicated. Some of the theoretical and practical aspects of protection through water immersion are still imperfectly understood. It seems, however, that an immersed subject is suspended between the force caused by acceleration and an opposite and nearly equal force due to buoyancy. Thus, the forces acting upon the subject cancel each other.

### Backward Seats Safest

Centrifuge experiments have been encouraging. Subjects wear breathing masks that supply air under pressure. One subject successfully withstood 31 g for five seconds *without losing consciousness*, and without much effect upon normal limb movements.

Colonel Stapp's findings on the decelerator have been put to practical use. His experiments showed that airplane seats should be placed with their backs toward the nose of the plane. As a result, all Air Force Military Air Transport planes are being so equipped.

Other of Stapp's findings are being used today in the design and testing of the Project Mercury space capsule, and in the training of the astronauts.

Colonel Stapp had a hand in another wind-blast experiment besides his rocket sled tests. He went up in an F-89 jet

fighter with its canopy removed. He stayed with his plane at a speed of 570 miles per hour. He suffered no ill effects from the blast of the wind. This experiment showed that it was safe for a pilot to remain with his plane if the canopy blew off.

Colonel Stapp took 29 rides on the "human decelerator." These experiments were risky. He sustained two wrist fractures, a rib fracture, retinal hemorrhage, and moderate degrees of concussion. But he succeeded in pushing ahead the frontiers of the new science of aviation medicine.

### "I Hate Danger"

"Why do you take these risks? Do you like danger?" the colonel was asked.

"I hate it," Colonel Stapp answered, "and I hope that the experiments I'm making will take some of the danger out of flying planes and driving cars—even riding rocket ships!"

"My first experience with the effect of gravity on people came in Brazil," Colonel Stapp once told a reporter. "One day I climbed to the top of a mango tree in our backyard—and took a 35-foot tumble to the hard, hard ground."

Colonel Stapp was born in Bahia, Brazil, in 1910 to American missionary parents. Young John was raised among Portuguese-speaking students and teachers, and first learned to speak English when his family visited the U. S. on vacation in 1916. He was not fed until he asked for food in English. He learned English quickly.

At 13 he was enrolled in the San Marcos Baptist Academy in Texas, where he played bassoon in the school band. His bassoon playing, he says, developed his lungs, so that he was able to make the track team when he entered Baylor University in 1927.

Although he enrolled as an English major, Stapp's career interest was suddenly changed by a tragic incident during the Christmas vacation of his sophomore year. He was visiting some relatives in Burnet, Tex., when his two-year-old cousin crawled too close to an open fireplace and was severely burned. The baby died. It was then that Stapp decided to become a doctor.

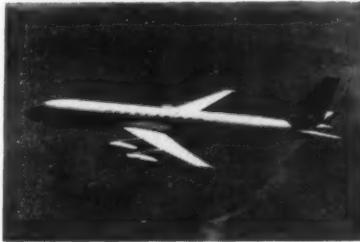
The road to medical school was a hard one for John Paul Stapp. His parents could not afford to send him more than 50c a day on which to live during his college years. When he graduated in 1931, he did not have enough money for medical school, although he had worked summers as a door-to-door salesman of cooking ware. He stayed on at Baylor and earned his master's degree in zoology in 1932.

(Continued on page 30)

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## Project Pointers

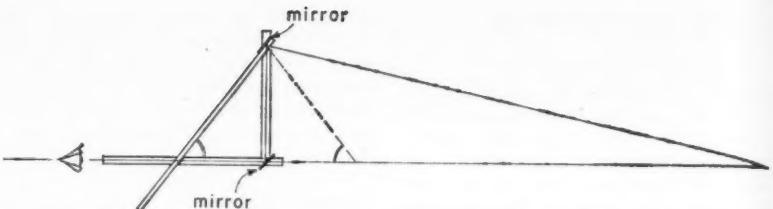
(Continued from page 27)

firmly. Sight down the center line on the sighting arm and note that the reflection of the base-line arm appears to be a continuation of the sighting arm, as shown in the drawing on page 27.

Now, on the base-line arm draw a pencilized center line whose reflection in the fixed mirror appears to be perfectly in line with the center line on the sighting arm.

Center the pivot holes accurately along this new line. The frame is now in perfect alignment.

Mount the mirror-arm assembly by plugging it into the outermost hole in the base-line arm. Set the range finder on a box or other support and line up the sighting arm with some well-defined object about a half mile or more distant so you can see the object just above the fixed mirror as illustrated in the drawing.



Drawing above shows how the optical range finder can be used for sighting distance.

Adjust the mirror-arm position by moving its lever, so that the reflection of the object by way of both mirrors appears to be just below the actual object seen directly. If you find that the direct and the reflected views are widely spaced one above the other, adjust the vertical angle of the rotatable mirror by placing a strip of paper, cardboard, or tape between the mirror and its block. In this way, you can make the mirror lean over slightly one way or the other to bring the images together.

### Calibration

A good standard for progressive measurements can be your school's football field, marked off, as it is, with lines 10 yards apart. By standing on the goal line at the junction of the goal line and one side line and sighting on a classmate as he stands on the side line at each 10-yard line, you can calibrate your range finder in 10-yard intervals up to about 50 yards.

If the football field is not available, the gymnasium can be used with bricks placed at measured distances.

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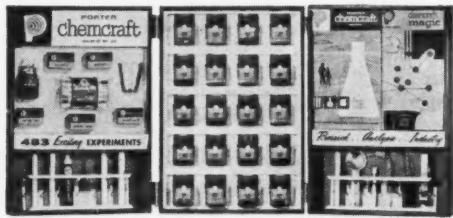
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### Fastest Man

(Continued from page 29)

After teaching zoology for two years at Decatur College (Texas), Stapp went to the University of Texas, where he received his Ph.D. in biophysics in 1940. Finally, at the age of 29, he was able to enter the University of Minnesota medical school. Earning his tuition as a research assistant, he was graduated as a doctor in 1944. He spent a year interning at a hospital and then joined the U.S. Medical Corps.

He entered the rocket field in 1946 when he was named project officer at the Aero-Medicine Laboratory at Holloman. He became the lab's chief in 1953. In 1959, he was elected president of the American Rocket Society. Until recently, Colonel Stapp was assigned to the Wright Air Development Division at Wright-Patterson Air Force Base in Dayton, Ohio. This lab works on man's survival in space.

On the first of September, Colonel Stapp and his wife (Lilli Lanase, a former prima ballerina of the Ballet Theatre of New York) reported to his new assignment. At the Aero-Medicine School in San Antonio, Colonel Stapp will train young doctors and technicians to continue his research.

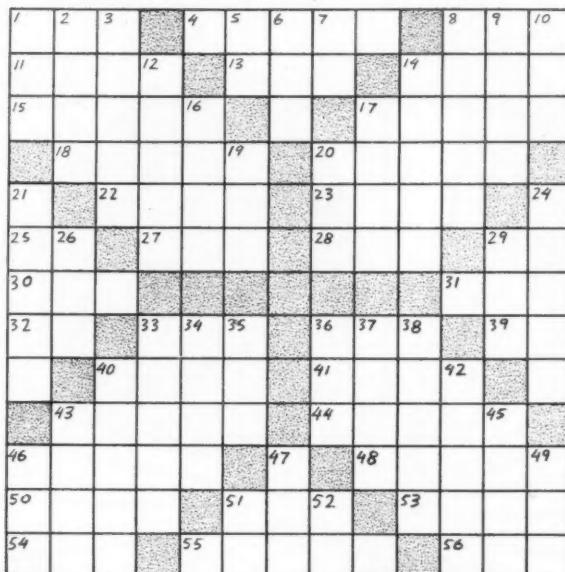
Says he: "I hope that more young people who enter medicine will take up research. We just don't have enough doctors working at the job of finding out new things." The fastest man on Earth will teach other young men how to become, perhaps, the fastest men

# Chemistry Compounded

By Josephine Poff, Willis High School, Willis, Va.

\* Starred words refer to chemistry

Students are invited to submit original crossword puzzles for publication in *Science World*. Each puzzle should be built around one topic in science, such as astronomy, botany, geology, space, electronics, famous scientists, etc. Maximum about 50 words, of which at least 10 must be related to the theme. For each puzzle published we will pay \$10. Entries must include symmetrical puzzle design, definitions, answers on separate sheets, design with answers filled in, and statement by student that the puzzle is original and his own work. Keep a copy of puzzles cannot be returned. Give name, address, school, and grade. Address Puzzle Editor, *Science World*, 33 West 42nd Street, New York 36, New York. Answers to this puzzle are on page 28.



## ACROSS

- \* 1. Mixture of gases enveloping Earth.
- \* 4. Compound of hydrogen and oxygen.
- 8. Doctor of Philosophy (*abbr.*).
- 11. Large or heavy (*French*).
- \* 13. Silvery, ductile corrosion-resistant metal, chemical symbol Sn.
- \* 14. An \_\_\_\_\_ spectrum is obtained by bombarding chemical elements with cathode rays.
- 15. Tetrabromofluorescein.
- 17. River which flows through Paris.
- \* 18. Its chemical symbol is Nt.
- 20. Marshes through which the Pripet River flows in Russia.
- \* 22. Inert rare gas, chemical symbol Ne.
- \* 23. Smallest unit of an element.
- \* 25. Symbol for new name suggested for Radon.
- 27. Region of clouds.
- 28. Male descendant.
- \* 29. Helium (*chemical symbol*).
- \* 30. Mixture of hydrocarbons and organic bases resulting from carbonization of coal.
- \* 31. Mixture of glyceryl esters of certain organic acids.
- \* 32. Chemical symbol for astatine.
- \* 33. Matter without definite shape or volume.
- \* 36. Manganese sulfide (*chemical symbol*).
- \* 39. Lanthanum (*chemical symbol*).
- \* 40. Silicates.
- 41. Cut by an ax.
- 43. Demon.
- \* 44. An unsaturated fatty acid, C<sub>17</sub>H<sub>32</sub> COOH.
- 46. Given doses.
- 48. In Greek mythology, a river in Hades.
- 50. Scent o: smell.
- \* 51. Charged atom or molecule.
- 53. Sulfinate.
- 54. 2,000 lbs.
- \* 55. Heaviest inert gas, liberated by disintegration of radium.
- \* 56. Suffix used in forming names of certain hydrocarbons.

## DOWN

- 1. Length of life.
- \* 2. Its chemical symbol is Fe.
- \* 3. Colophony.
- 5. Ampere turn (*abbr.*).
- 6. Equal in a contest.
- 7. Half the width of an em in printing.
- 8. Triangular glass piece which separates rays of light into colors.
- 9. Skein of yarn.
- \* 10. Coloring matter with chromophore and auxochrome groups.
- 12. Specific scenes or positions.
- \* 14. An inert gas, its symbol is Xe.
- 16. Corner.
- \* 17. Combining form meaning grain.
- 19. North New York (*abbr.*).
- \* 20. Para-amino salicylic acid (*abbr.*).
- 21. Leaf of a corolla.
- \* 24. Element characterized by luster, malleability, conductance of heat and electricity.
- 26. Pad used in wrestling.
- \* 29. Halogen (*chemical abbr.*).
- 33. One who gives.
- \* 34. Hydrogen ion donor.
- \* 35. Salt.
- 36. Unit of electrical conductance.
- 37. Nickname for Helen.
- 38. Use a broom.
- \* 40. Subatomic particle of matter.
- \* 42. Potassium nitrate.
- 43. Extinct bird.
- 45. Fictional Chinese detective, Charlie \_\_\_\_\_.
- 46. Short click on telegraph.
- 47. Contains seeds of legume plant.
- 49. Sensory organ of vision.
- 51. Iowa (*abbr.*).
- \* 52. Nobelium (*chemical symbol*).

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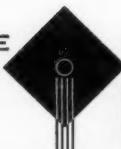
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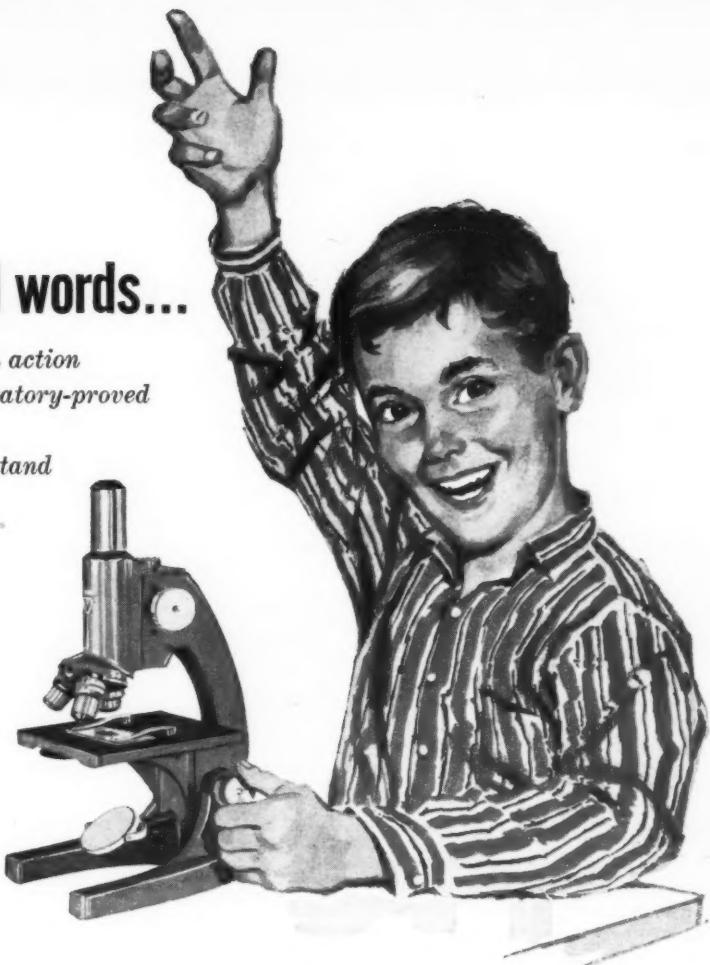
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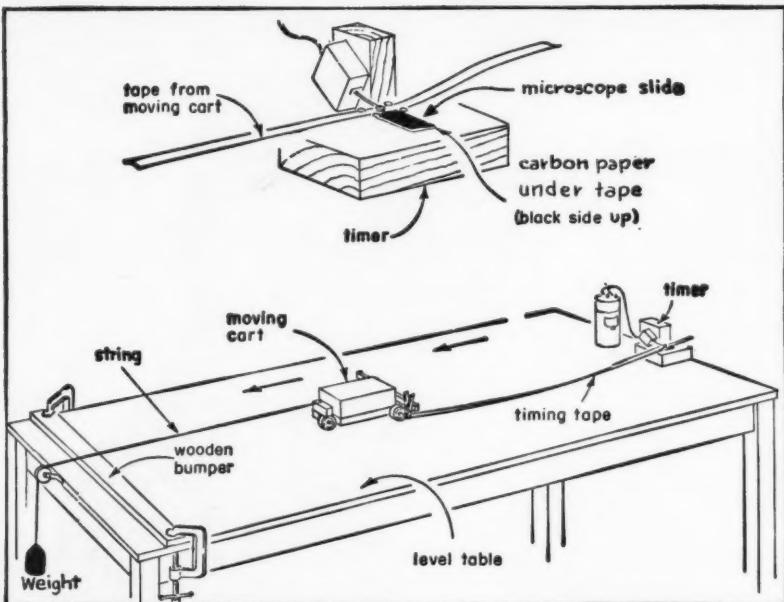
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7-T

# Demonstrations and Experiments



The simple setup diagrammed above can be used to study increase in acceleration.

## Acceleration Timer

To demonstrate a quantitative method for measuring acceleration along a horizontal plane, a simple timing device can be made from an electric bell as in the diagram above. Note that the bell gong is removed. A microscope slide is placed on the block under the hammer of the bell clapper. Four thumb tacks are used as guides for white paper tape such as adding machine tape cut to size. A square of carbon paper with the black side up against the paper tape rests on the microscope slide.

Next, you need a smooth level table. A length of tempered masonite placed on a flat table provides a very smooth surface. The cart may be a roller skate or a 2 x 4 length fitted with roller skate wheels. The left end of the cart is fitted with a string that passes over a low friction pulley placed at the left end of the table. The paper tape is attached to the other end of the cart and passes under the bell clapper as in the diagram. Attach a weight to the end of the string.

Now connect one or two dry cells to the bell to get it operating. Release the weight. The cart will move toward the left under constant acceleration. When the run is completed, remove the paper tape. Now examine the record of dots. The time between any two dots is constant. Students can measure the increase in velocity in each time interval by measuring the distance be-

tween dots. From this they can measure the acceleration as the rate of change between each two adjoining groups of dots. Most small electric bells operate at about 50 cycles on one dry cell. In such a case the time between dots on the tape is 1/50 second.

## Analysis of Motion

Motion in a plane can be successfully studied by the analysis of pictures taken with an open-shutter camera behind a rotating slotted disk, by a technique developed by John Moreau of Reno (Nevada) High School. For objects acting under forces comparable to that of gravity during the first second of motion, the exposure rate of 20 to 30 per second is quite adequate.

Film with an emulsion speed of 200 or better has been found to be satisfactory with simple side lighting by two high wattage or photoflood bulbs on one side, and with a diffusing reflector on

the other. An open door into an unlighted room makes a very satisfactory black background for the exposure. Distance scales may be made by placing masonite pegboard with drinking straws in it, or corrugated cardboard, with one side within the field of the camera. These should be placed in the same plane in which the motion is occurring.

The strob ing mechanism may be a motor-driven disk with narrow slots cut in the rim which moves very close to the open lens. If a synchronous motor of sufficient speed and power is available, it will not be necessary to calibrate it. If a slit or hole is cut near the edge of a heavy disk phonograph record, it may be rotated by hand at a nearly constant speed.

The moving object should have a matte white surface. Solid ivory or celluloid balls, and enameled or painted wooden, rubber, or steel balls have been found satisfactory. Roll them down a smooth table slightly inclined to use gravity for constant acceleration.

A photograph of a freely falling object may be studied to determine instantaneous and average velocities and acceleration with considerable accuracy. Also, the conservation of mechanical energy (kinetic and potential) may be confirmed by readings taken throughout the motion. A ball tossed in an arc within the field of view of the camera will show uniform horizontal velocity, constant vertical acceleration, and give further points at which to take readings for demonstrating the principle of conservation of energy.

A ball bouncing may be photographed with either strobe or regular open-shutter method, and the loss of energy in each bounce will produce data for a decay curve, since the same fraction of energy is given up in each bounce.

## Contours

A set of "contours" may be a useful permanent addition to your classroom equipment. With the help of the shop teacher you can make a large set.

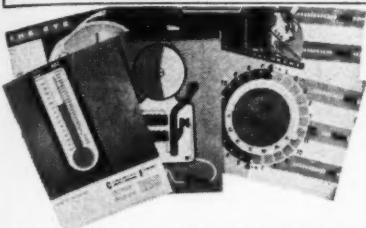
Using scrap plywood lay out several irregular, smoothly curved shapes. Each piece should be approximately  $\frac{1}{2}$ -inch shorter and narrower than the preceding piece. Thus, when piled up the several layers—each of which is a "contour"—will make a hill. If the inside of the contour is trimmed out the hill will be lighter.

If the hill is dismantled and the "contours" used as templates for a drawing on the board, the relationship between terrain features and contour lines on a map usually becomes clear to most students.



Simple strobe device is shown above.

"Portable Laboratories" for the classroom



## How to dramatize science in the primary grades.

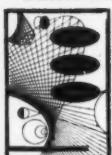
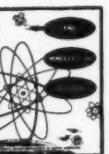
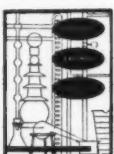
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## News and Views

(Continued from page 1-T)

## Science Talent Search

This month seniors in 30,000 public, private, and parochial high schools all over the United States are being invited to enter the Twentieth Science Talent Search for the Westinghouse Science Scholarships and Awards.

Conducted by Science Clubs of America, an activity of Science Service, and supported by the Westinghouse Educational Foundation of the Westinghouse Electric Corporation, the "Search" is designed to discover the nation's most promising young research scientists. Science scholarships and awards totaling \$34,250 are provided for the winners, to assure their professional training and future careers.

Detailed information and suggestions for entering the competition are included in a booklet, "How You Can Search for Science Talent," which is now being sent to principals and science teachers. Address requests to Science Service, 1719 N Street, N.W., Washington 6, D.C.

## Club Sponsor's HELP-BOOK

A brand new edition of the Science Clubs of America *Sponsor Handbook* offers answers to sponsors' questions and supplies a variety of ideas and guideposts. The handbook is published by Science Service, which administers Science Clubs of America.

Whether your club is on its maiden voyage this year or is a solidly established fixture in your school and community, you can encourage younger students to form their own science clubs. Children in even the earliest grades of elementary school have a wonderful time getting the "hang" of science and exploring the world of "how" and "why." Specific help for sponsors of elementary clubs has been included in the new handbook.

## Scholarships for Teachers

Shell Companies Foundation, Inc., has provided 60 graduate fellowships and 25 research grants worth \$390,000 for the 1960-61 academic year.

The 60 Shell fellowships have been awarded to graduate students and young teachers working for advanced degrees in 44 colleges and universities.

(Continued on page 10-T)

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10-T

## News and Views

(Continued from page 9-T)

The 25 Shell research grants have been made to 19 privately supported colleges and universities to assist them generally, and to help support their graduate programs in fundamental research.

The research grants — worth \$7,500 each—are for graduate study in physics, chemistry, mathematics, geology, and engineering fields.

Each of the 60 graduate fellowships includes payment of all tuition fees for the school year, plus a stipend to meet living expenses. For more information write to Shell Companies Foundation, Inc., 50 West 50th Street, New York 20, New York.

## Science Book Review

Fun for the young scientist seems to be the theme of many of the publishers this fall. *Edison Experiments You Can Do* (Harper, \$2.50) gives details on experiments—based on Edison's original notebooks—that can be performed by science students, ages 11 and up. *One Hundred and One Science Experiments*, by Illa Podendorf (Children's Press, \$4.50), have been done by scientists and may be performed safely by children. Experiments deal with air, magnets, electricity, water, heat, sound, light, machines, chemistry, and plants. (For ages 9 to 12.)

The latest information on electronics is now available in the new fourth edition of *Electronics for Young People*, written and illustrated by Jeanne Bendick (Whittlesey House, \$3.50). In this latest revision, the author gives a clear account of new developments (nuclear energy, automation, miniaturization, and more) and retains the explanations of electronic principles that have been so helpful to young people and adults.

For space-age reference, there is the new edition of *The Space Encyclopedia*, edited by M. T. Bizony (Dutton, \$9.50). It combines details on missiles, satellites, and space research with a survey of all branches of astronomy. It contains 320 illustrations, maps, and diagrams. A well-organized guide to astronomy is *A Beginner's Guide to the Skies*, by R. Newton and Margaret Mayall (Putnam's, \$2.50). It is especially good for new teen stargazers. *First Men to the Moon*, by Wernher von Braun (Holt, Rinehart, and Winston, \$3.95), is a fascinating dramatization of the first voyage to the moon. In addition, with questions and answers and drawings, it gives most of the essential infor-

mation the reader needs to know about travel in space. (All ages.)

*Starbound*, by Raymond and Eileen Schussler (Putnam's, \$2.75), tells the story of rocketry, past, present, and future, in language that the 10-to-14-age youngsters will understand. *Rockets of the Army*, by Erik Bergaust (Putnam's, \$2.50), is another of the author's successful up-to-the-minute collections of rocket photographs and data. All the missiles now in the Army arsenal are in this book, from the Nike to the new, complex LaCrosse. *Project Mercury*, by Charles Coombs (Morrow, \$2.75), describes what has been done and what will be done to launch a man into space in the near future and return him to Earth. (Ages 8 to 10.)

*Rays and Radiation*, by Robert Scharff (Putnam's, \$2.75), explains the kinds of rays that make up the electromagnetic spectrum today. (Ages 8 to 12.) What happens when an atomic submarine goes on a practice patrol under the sea is described clearly in text and pictures in *The Atomic Submarine*, by Russell Hoban (Harper, \$2.50).

What may well be a classic reference volume on an ancient Central American civilization is *Maya Cities*, by Paul Rivet (Putnam's, \$5.95). In this illus-

your students will  
 get more out of their  
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## HOW TO STUDY AND TAKE EXAMS

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SCIENCE TEACHERS WORLD

trated work, the author, a distinguished French anthropologist, describes with clarity the Mayan peoples, their language, mode of living, beliefs, cities, and arts. A new paperback, *Ancient Semitic Civilizations*, by Sabatino Moscati (Capricorn, \$1.65), reviews the civilizations of Babylonia, Assyria, Canaan, ancient Arabia, Ethiopia, and Israel.

An interesting subject for 10-to-14-year-olds is tunnels. *Tunnels*, by Fon Boardman, Jr. (Henry Z. Walck, \$3.50), tells the exciting history of tunnels from prehistoric times to the present.

### Brief Book Notes

The following capsule reviews are impressions of books recently received by *Science World*.

Burger, Carl, *All About Fish* (Random House, \$1.95). Another in the well-known "All About" series. This new addition to the series presents some elementary facts about the natural history of fishes in simple language. Like its predecessors, the book is accurately and pleasingly illustrated. *All About Fishes* should be of interest to upper grade pupils and some junior high school students.

Brown, Lloyd A., *Map Making, The Art That Becomes a Science* (Little, Brown, \$4.75). The sub-title accurately describes the contents of this beautiful and informative book which charts the history of scientific cartography from Ptolemy to the twentieth century. This book is not a book of techniques or projects. It is a lucid discussion of problems and concepts involved in the metamorphosis of cartography from illustration into a science. The reading level is suitable for ninth graders and above.

Chambers, Robert Warren and Alma Smith Payne, *From Cell to Test Tube* (Scribner's, \$3.50). This simplified popular introduction to biochemistry discusses major concepts: cells, enzymes, proteins, metabolism, ATP, and the nucleic acids in language that high school students can handle. *From Cell to Test Tube* may interest your able biology students in biochemistry as a career. The authors are a professor of biochemistry (Chalmers) and a science supervisor (Payne). Suitable for ninth grade and up.

Hamilton, Russel, *Science, Science, Science* (Watts, \$2.95). As you might expect from the title, this is a *pot pourri*—a selection of sketches of famous scientists and their achievements. The style is breezy and interesting. The information appears to be well researched and accurate. The intellectual history of science is too much neglected in our

schools and efforts in this direction are to be lauded.

Hanrahan, James S. and David Bushnell, *Space Biology* (Basic Books, \$6.00). A comprehensive survey of concepts and problems in the biophysics of space exploration. This book is for the teacher who will draw much from it to interest and enrich biology classes. Students capable of independent adult level reading, willing to go a little afield for more background when the going gets tough, will also profit.

Moore, Patrick, *A Guide to the Stars* (Norton, \$4.95). Not an amateur astronomer's handbook, but another popular account of astrophysics. A good one, this is on the adult level.

Philips, Mary Geisler, *Dragonflies and Damselflies* (Crowell, \$2.50). This simply written, well-illustrated book describes where the *Odonata* may be found, and how to collect, preserve, and identify them. Interesting for anyone—from junior high school on up.

Styler, Herman, *Plague Fighters* (Chilton, \$3.50). This is a non-technical account of man's war against disease with particular emphasis on the adventures of plague fighters. Exciting, inspirational reading for junior high school students.

*The Doubleday Pictorial Library of Science* (Doubleday, \$9.50). Prepared

under the editorial supervision of Julian Huxley, J. Bronowski, and others, this handsome volume presents authoritative synopses of the physical sciences. The AAAS considers this volume a *must* for high school libraries.

### Magazines for Friendship

Be an ambassador of good will. Send your back copies of *Science World* to a high school or university student or knowledge-hungry adult living in Asia. A clearing house for such a project is now in operation. Mrs. Henry Mayers of Television station KNXT, Hollywood, Calif., is volunteer coordinator for this "Magazines" project.

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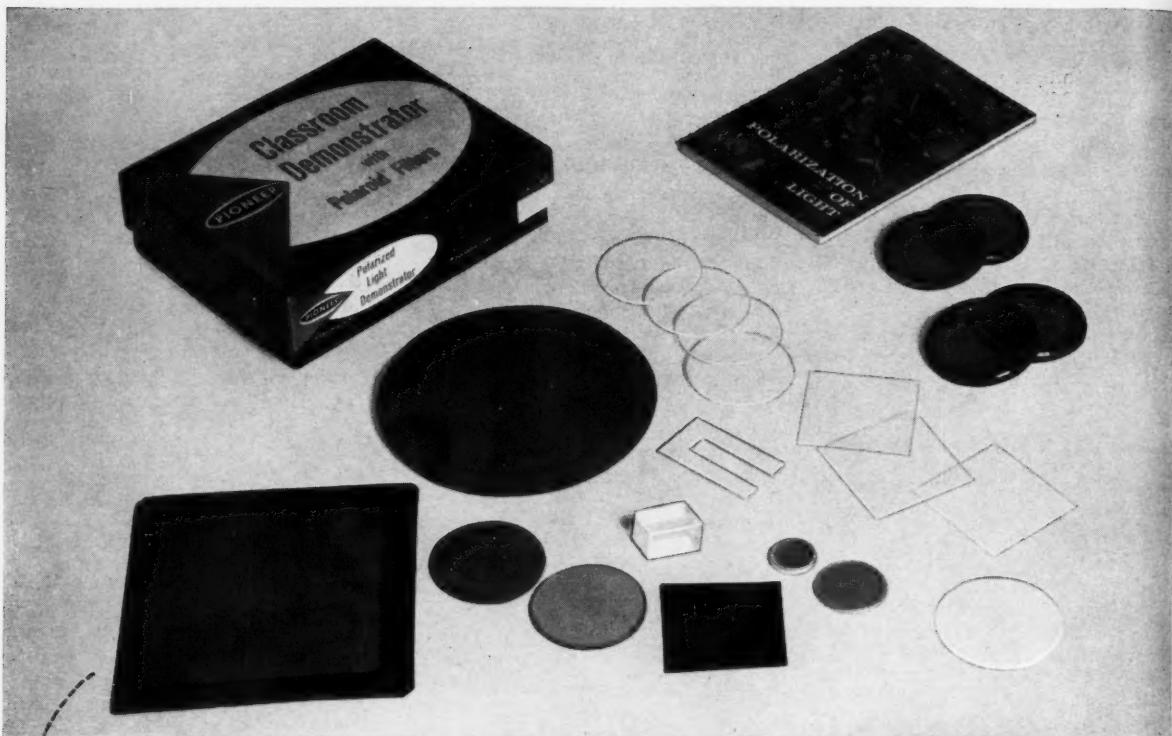
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